PB81-183626

Wastewater Management Plan for the Durango Area La Plata County, Colorado. Environmental Impact Statement, Appendices

Engineering-Science, Inc.
Denver, CO

Prepared for

Environmental Protection Agency
Denver, CO

Feb 81

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA- 908/5-81-001 B

2.

3. RECIPIENT'S ACCESSION NO.
PB81 183626

4. TITLE AND SUBTITLE
Draft Environmental Impact Statement Appendices
Wastewater Management Plan for the Durango Area
La Plata County, Colorado

5. REPORT DATE
February 1981

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
John M. Brink, EPA
Gary L. Potter, Engineering Science

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
ENGINEERING SCIENCE, Inc.
2785 North Speer Blvd., Suite 140
Denver, CO 80211

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency, Region VIII
1860 Lincoln Street
Denver, CO 80295

13. TYPE OF REPORT AND PERIOD COVERED
Draft

14. SPONSORING AGENCY CODE
8W-EE

15. SUPPLEMENTARY NOTES
Complements Environmental Assessment dated September 10, 1979

The report

16. ABSTRACT

Appendix A contains detailed descriptive material and background data on the environmental setting of the wastewater management plan analyzed in the Environmental Impact Statement (Report No. EPA 90815-81-001A). Appendix B contains additional documentation of the impact analysis for the study.

for the Durango area, La Plata County, Colorado.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Sewer Interceptor Individual Disposal Systems Privately Owned Small Wastewater Treatment Systems Local Land Use Plans Environmental Impact Statement	City of Durango La Plata County, Colorado	

18. DISTRIBUTION STATEMENT
Release Unlimited

19. SECURITY CLASS *(This Report)*

20. SECURITY CLASS *(This page)*

21. NO. OF PAGES

22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

PB81-183626

United States
Environmental Protection
Agency

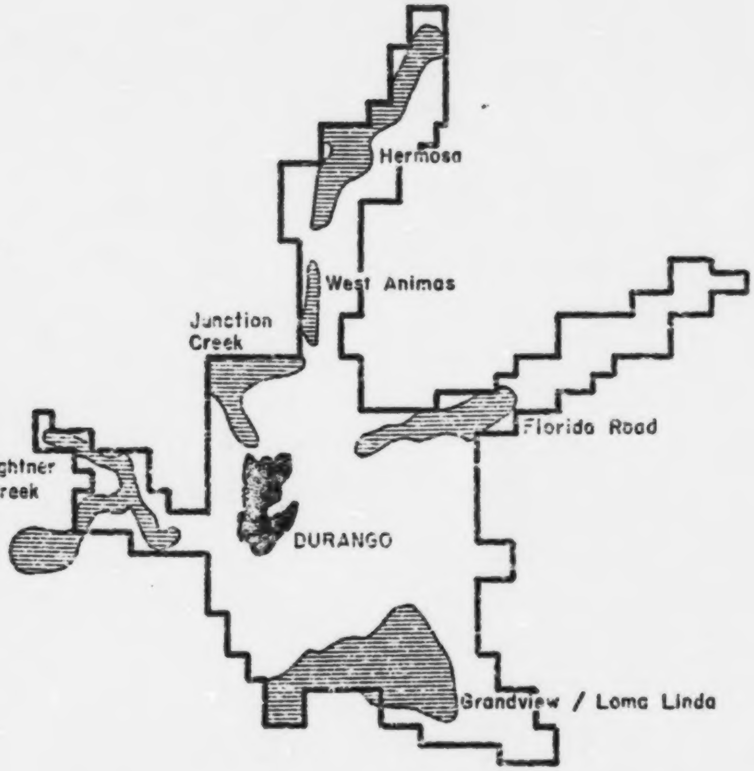
Region 8
1860 Lincoln Street
Denver, Colorado 80295

EPA 908/5-81-001B
January, 1981

EPA

Environmental Impact Statement

APPENDIX


Hermosa
West Animas
Junction Creek
Florida Road
Lightner Creek
DURANGO
Grandview / Loma Linda

Wastewater Management Plan for the Durango Area, La Plata County, Colorado

PRODUCT OF:
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER MANAGEMENT PLAN FOR THE DURANGO AREA, LA PLATA COUNTY, COLORADO

APPENDICES

Prepared for

U.S. Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80295

December 1980

By

ENGINEERING-SCIENCE
2785 North Speer Boulevard
Denver, Colorado 80211

i.a

TABLE OF CONTENTS

Page

FIGURES

TABLES

APPENDIX A ENVIRONMENTAL SETTING, DURANGO, COLORADO A-1

The Setting A-2
Topographic Features A-3
Geology A-4
Soils A-8
    Animas River Valley A-8
    Florida River Valley A-21
    The Florida Mesa A-25
    Lightner Creek A-28
    Junction Creek A-31
Flood Plain A-32
Vegetation A-33
Wildlife A-63
Aquatic Life A-70
    Fish A-70
    Aquatic Invertebrates A-77
Threatened and Endangered Species A-78
Surface Water Quality A-80
    Water Quality Standards A-80
    Animas River A-89
    Lightner Creek A-101
    Hermosa Creek A-104
    Junction Creek A-104
    Florida River A-104
    Dischargers A-108
Groundwater Quality A-113
    Data Sources A-113
    Groundwater Data Evaluation A-116
    Lightner and Junction Creek Areas A-123
    Florida River Area A-124
    Florida Mesa Area A-125
Supplemental Water Quality Monitoring Program A-127
    Surface Water Monitoring A-129
    Groundwater and Spring Water Monitoring A-132
    Conclusions A-135

TABLE OF CONTENTS (continued)

Page

Population, Socioeconomic Factors, Land Use A-137
- Existing Conditions A-137
    - Recent Growth Trends A-137
    - Sources of Past Growth A-138
    - Tourism A-139
    - Part-time residents A-141
    - In-migrants A-142
- Growth and the Housing Supply A-142
- Future Growth A-143
    - Influences of Future Growth A-143
    - Tourism A-143
    - Energy resources development A-144
    - Agriculture A-145
    - Factors discouraging growth A-146
    - Growth Projections A-147
    - Accuracy of Projections A-150
- Area 1: Hermosa A-154
    - Current Level of Development A-155
    - Influences on Future Development A-156
    - Physical constraints A-156
    - Land ownership A-157
    - Land use planning A-157
    - Proposed major developments A-157
    - Infrastructure A-158
    - Local attitudes A-159
    - Summary A-159
- Area 2: Junction Creek A-160
    - Current Level of Development A-160
    - Influences on Future Development A-160
    - Physical constraints A-160
    - Land ownership A-161
    - Land use planning A-161
    - Proposed major developments A-161
    - Infrastructure A-162
    - Local attitudes A-163
    - Summary A-163
- Area 3: Lightner Creek and Durango West A-163
    - Current Level of Development A-164
    - Influences on Future Development A-164
    - Physical constraints A-165
    - Land ownership A-166
    - Land use planning A-166
    - Proposed major developments A-166
    - Infrastructure A-166
    - Local attitudes A-167
    - Summary A-167

TABLE OF CONTENTS (continued)

Page

Area 4: Grandview-Loma Linda A-167
- Current Level of Development A-167
- Influences on Future Development A-169
- Physical constraints A-169
- Land ownership A-169
- Land use planning A-169
- Proposed major developments A-169
- Infrastructure A-170
- Local attitudes A-170
- Summary A-170

Area 5: Florida Road A-171
- Current Level of Development A-171
- Influences on Future Development A-172
- Physical constraints A-172
- Land ownership A-173
- Land use planning A-173
- Proposed major developments A-173
- Infrastructure A-173
- Local attitudes A-174
- Summary A-174

Area 6: West Animas A-174
- Current Level of Development A-174
- Influences on Future Development A-175
- Physical constraints A-175
- Land ownership A-175
- Land use planning A-175
- Proposed major developments A-175
- Infrastructure A-176
- Local attitudes A-176
- Summary A-176

Summary of Study Area Development and Development Conditions A-176

Other Potential Sites for Development A-178
- Unincorporated Private Lands Near the City of Durango A-178
- Areas North of Hermosa A-179

Meterology and Air Quality A-180
- Meterology A-180
- Air Quality A-181

REFERENCES A-184

APPENDIX B ENVIRONMENTAL IMPACTS B-1

Topography B-2
- Project Impacts B-2
- Mitigation Measures B-2

Geology B-2
- Project Impacts B-2

TABLE OF CONTENTS (continued)

Page

Mitigation Measures B-3
Soils B-3
Project Impacts B-3
Mitigation Measures B-4
Water Resources - Surface Water Hydrology B-4
Project Impacts B-4
Mitigation Measures B-6
Water Resources - Surface Water Quality B-8
Project Impacts B-8
Mitigation Measures B-8
Water Resources - Ground Water Quality B-8
Project Impacts B-8
Mitigation Measures B-10
Biological Resources - Vegetation B-10
Project Impacts B-10
Mitigation Measures B-11
Biological Resources - Wildlife and Special Status Species B-11
Project Impact B-11
Mitigation Measures B-13
Biological Resources - Aquatic Life B-13
Project Impacts B-13
Mitigation Measures B-14
Meterology and Air Quality B-15
Project Impacts B-15
Mitigation Measures B-15
Energy Resources B-15
Project Impacts B-15
Mitigation Measures B-16
Transportation B-16
Project Impacts B-16
Mitigation Measures B-16
Land Use and Population Considerations B-17
Project Impacts B-17
Mitigation Measures B-18
Socioeconomic Considerations B-18
Project Impacts B-18
Mitigation Measures B-19
Cultural Resources B-19
Project Impacts B-19
Mitigation Measures B-20

LIST OF FIGURES

		Page
A - 1	Areas Potentially Constrained for Development by Geologic Hazards - Hermosa Study Area	A-10
2	Areas Potentially Constrained for Development by Geologic Hazards - Junction Creek Study Area	A-11
3	Areas Potentially Constrained for Development by Geologic Hazards - Lightner Creek/Durango West Study Area	A-12
4	Areas Potentially Constrained for Development by Geologic Hazards - Grandview/Loma Linda Study Area	A-13
5	Areas Potentially Constrained for Development by Geologic Hazards - Florida Road Study Area	A-14
6	Areas Potentially Constrained for Development by Geologic Hazards - West Animas Study Area	A-15
7	Historic Water Quality Sampling Points	A-90
8	Point Source Dischargers in the Study Area	A-109

LIST OF TABLES

		Page
A - 1	Soil Limitations and Development Capabilities	A-16
2	Plants of the Study Area	A-35
3	Wildlife Species of the Study Area	A-64
4	Fish Inventory Based on Electro-Fishing	A-71
5	Macro-Invertebrates of Selected Streams	A-73
6	Colorado Water Quality Criteria	A-81
7	Water Quality Data - Animas River	A-91
8	Water Quality Data - Lightner Creek	A-102
9	Water Quality Data - Hermosa Creek	A-105
10	Water Quality Data - Florida Creek	A-107
11	Animas River Drainage Point Source Discharge Inventory	A-110
12	Junction Creek Trailer Park Discharge Data	A-114
13	Standards for Domestic Groundwater Supply	A-115
14	Study Area Well Information	A-117
15	Groundwater Quality Data	A-118
16	Field Monitored Parameters Surface Water Quality	A-130
17	Results of Chemical and Bacterial Analyses on Surface Waters of the Animas and Florida Rivers	A-131
18	Results of Chemical and Bacterial Analyses on Groundwater and Spring Water Grab Samples	A-134

LIST OF TABLES (continued)

		Page
19	Recent Population Growth in La Plata County and Durango	A-138
20	Recent Population Growth in the State of Colorado Planning and Management Region 9	A-139
21	Representative Visitor Statistics	A-141
22	La Plata County Population Projections - Year 2000	A-148
23	Comparative Sample Land Prices in the 201/ EIS Study Area	A-153
24	Recent Residential Construction in Hermosa Study Area	A-156
25	Proposed Major Developments; Hermosa Study Area	A-158
26	Major Developments in the Junction Creek Study Area	A-162
27	Building Permits Issued in Lightner Creek-Durango West Study Area, 1977-1980	A-165
28	Recent Residential Construction in Grandview Loma Linda Study Area	A-168
29	Recent Residential Construction in Florida Area	A-172
30	Summary of Existing Development and Development Conditions, Durango 201 Study Areas	A-177
31	Air Quality Data for Durango	A-183

APPENDIX A

ENVIRONMENTAL SETTING

DURANGO, COLORADO

This appendix presents the existing environmental data base which was used to evaluate the impacts of the alternatives developed for the 201 Facilities Plan. The focus of the appendix is on the following environmental features of the Study Area: geology, soils, flood plains, vegetation, wildlife, and groundwater and surface water quality.

To compile this data base, a wide variety of data sources were contacted. The data from the various sources are of variable completeness, ranging from broad, general information to very point specific information. Occasionally, data provided by the same source presented conflicts in terms of completeness, unity, or analysis. However, the assembled data base does provide adequate information to identify key environmental units for the analysis of wastewater management alternatives. The following key units have been identified:

- Geologic features
    - Depth to bedrock
    - Geologic hazards
- Soils
    - Permeability
    - Depth to groundwater
    - Development suitability
    - Septic tank/leach field suitabilities
- Designated flood plains

- Vegetation/wildlife/aquatic life
    - Critical big game habitat
    - Threatened/endangered species habitat
    - Fisheries
- Water quality
    - Potential groundwater quality problems
    - Potential surface water quality problems

These various environmental features of the Study Area were used in the development of the EIS.

During the review and analysis of the existing water quality data (surface and ground) it became apparent that the data were inconsistent, dated, and insufficient to determine current water quality problems in the Study Area. Furthermore, it was not possible to determine if previously identified water quality problems still existed, or if new problems had developed which were not documented. To provide general, up-to-date baseline information a water quality monitoring program was implemented. The results of this monitoring program are presented herein.

THE SETTING

The Study Area is located in southwestern Colorado on the Animas River. This drainage is tributary to the San Juan River of the Colorado River complex. The area is bordered by the San Juan Mountains to the north and west, and by plateaus and mesas to the south and east. The region is rich in cultural resources and is a popular recreational area for skiers, bikers, campers, and sightseers. Durango is the major population center in the Study Area; trade and tourism are its predominant businesses.

Various Indian groups inhabited the area from early history, leaving evidence of their presence in the Mesa Verde cliff dwellings southwest of the Study Area. Hispanic and Caucasian settlement occurred with the growth and expansion of railroads, trade, and mining in the mid-1800's. During the first half of the 20th century agriculture provided a marginal to stable living for residents but the various cultural groups retained a degree of separation. During the 1950's discoveries of energy and mineral resources expanded the population, but agriculture provided the underlying stability to the economy. During this period Durango prospered from increases in tourism, recreation related service industries, retail sales, and real estate expansion. Population increases have continued into the 1970's because of a westward movement of the nation's population and the increasing popularity of the southwest.

TOPOGRAPHIC FEATURES

Elevations in the Study Area range from about 6,400 feet to about 8,800 feet. The area is situated in a transitional area of the Southern Rocky Mountain Physiographic Province and the Colorado Plateau Province. The Rocky Mountain Province is characterized by high peaks, great relief, and ruggedness. Rocks are of igneous, metamorphic, and sedimentary origin, and soils are usually shallow. It is a scenic area of intermixed bare rock and forest, with valuable water and mineral resources. The Colorado Plateau Province, Navajo Section, consists of extensive areas of nearly horizontal sedimentary formations, structural upwarps, igneous structures, and steep walled canyons. It is an arid area of bare rock, sparse vegetation, and highly varied desert scenery.

Principal topographic features include the San Juan Mountains outside the Study Area to the north, Animas City Mountain northwest of Durango, Florida Mesa southeast of Durango, and the Animas River and its tributaries.

The Animas River headwaters are located in the San Juan Mountains north of the Study Area. The main stem Animas flows through a narrow canyon with steep slopes and sheer rock walls. The stream gradient is about 90 feet per mile (1.7 percent) and the stream is shallow. The Animas River flows into the Animas Valley at Baker's Bridge, where an abrupt change in gradient occurs. The gradient decreases to about 20 feet per mile (0.4 percent), and is a consequence of the glacial action which formed the valley. The meandering feature of the river is evidenced by the existence of several oxbow lakes which have formed in old stream channels. A terminal moraine exists at the north edge of Durango. Downstream of Durango, the valley is broad and the river has few meanders. The stream gradient is about 26 feet per mile (0.5 percent).

Hermosa Creek is a steep, swiftly flowing mountain stream throughout most of its length. Near its mouth it meanders into the Animas Valley in a broader channel. Junction Creek is also a swiftly flowing stream with well-defined channels. Dry Gulch Creek, a tributary of Junction Creek, has similar features. Dry Gulch Creek joins Junction Creek about one-half mile upstream from the confluence of Junction Creek with the Animas River. The Lightner Creek drainage lies to the south of the Junction-Dry Gulch Creek drainage and has similar features.

GEOLOGY

Within the Study Area there are nineteen geologic formations and eleven surficial deposits. Geologic features can be separated into two general groups along an east-west line north of the City of Durango. Formations north of this line form the basal structure of the southern edge of the San Juan Mountains; south of this line the geology has formed mesas and plateaus. Geologic formations north of the separation line range in age from the Upper Cretaceous to Precambian, while formations south range from Quaternary to Upper Cretaceous. Quaternary alluvium is common in most stream beds.

The geologic formations in the Study Area include:

- alluvial deposits (Quaternary)
- landslip debris (Quaternary)
- glacial drift (Quaternary)
- Animas Formation, McDermott member (Upper Cretaceous)
- San Jose, Nacimiento, and Animas Formations (Eocene, Paleocene, Upper Cretaceous)
- Kirkland Shale, Upper Shale Member (Upper Cretaceous)
- Kirkland Shale, Farmington Sandstone Member (Upper Cretaceous)
- Lewis Shale (Upper Cretaceous)
- Cliff House Sandstone (Upper Cretaceous)
- Point Lookout Sandstone (Upper Cretaceous)
- Mancos Shale (Upper Cretaceous)
- Dakota Sandstone and Burro Canyon Formation (Upper and Lower Cretaceous)
- Morrison Formation (Upper Jurassic)
- Entrada Sandstone (Upper Jurassic)

- Dolores Formation (Upper Triassic)
- Cutler Formation (Lower Permian)
- Rico, Hermosa, and Molas Formations (Lower Permain and Pennsylvanian)

Alluvial deposits consist of alluvium, terrace gravels, and alluvial fan deposits. The materials associated with the alluvium include silt, sand, and gravel associated with modern flood plains. Terrace gravels are old stream deposits lying on surfaces above the present flood plain. Alluvial fan deposits are sand, gravel, and wash deposits set down in a fan-shaped wedge at the mouths of tributaries. In the Animas River valley north of Durango the majority of the existing development has occurred on the alluvial deposits. Alluvial deposits are also found in the bottomlands of Junction Creek, Lightner Creek and the Florida River.

Northeast of Durango, in the Animas Valley, glacial till deposits can be found. These deposits are poorly sorted silt- to gravel-sized material deposited by glacial ice, primarily as terminal or lateral moraines.

The oldest formation in the Study Area is found at Baker's Bridge. This formation, Baker's Bridge Granite, is a pale-red, massive, medium to coarse-grained granite. It contains abundant perthite, plagioclose, and complexly altered hornblende and biotite. This is a rock outcrop with no surficial deposits associated with it.

Ascending out of the Animas Valley in the area north of Trimble, the geologic formations include Rico, Hermosa, and Molas Formations. The Rico Formation consists of nonmarine red beds of shale, siltstone, arkosic sandstone, and grit; it represents transitional beds between the Cutler and Hermosa Formations, and throughout much of the area is not recognizable as a distinct unit. The Hermosa Formation is largely dark-gray marine shale, siltstone, mudstone, and arkosic grit. Molas Formation is mostly nonmarine shale, siltstone, sandstone, conglomerate, and basal red breccia. Surficial deposits on these formations include areas of landslide deposits (jumbled masses of earth material derived from slope failure), and complex slope failure deposits (similar to landslide deposits, but include large areas of multiple slope failures).

The interface between the geologic formations and the alluvial valley consists of surficial deposits of colluvial wedges. These wedges consist of gravity-transported debris which occur as a lenticular wedge. In the Study Area north of Trimble development has been limited on these formations.

Above the Rico, Hermosa, and Molas Formations is the Cutler Formation. This is predominantly a nonmarine red shale, siltstone, sandstone, and limestone-pebble conglomerate. North of Durango this formation is located on the east and west side of the Animas Valley from Trimble south to Animas City Mountain. Surficial deposits at the Cutler-alluvium interface are the colluvial wedge deposits. Development has been primarily on the west side of the Animas Valley at the base of the Cutler Formation. Falls Creek cascades over the Cutler formation into the Valley.

South toward Animas City Mountain and the northern side of Junction Creek drainage, geologic complexities increase. Two formations, the Morrison and Dakota Sandstone-Burro Canyon, are found. The Morrison Formation is mostly vari-colored claystone and mudstone. The Dakota Sandstone disconformably overlies the Burro Canyon Formation. The Dakota Sandstone is a light-gray to brown sandstone with interbedded siltstone and carbonaceous shale. It commonly contains chert pebble conglomerate sandstone at the base, while the Burro Canyon is a lenticular chert-pebble conglomerate interlayed with green and gray claystone. Also occurring in the area is a thin band of Entrada Sandstone. This formation is a light-gray crossbedded sandstone. Surficial deposits associated with these formations include landslide deposits and complex slope failure deposits. Development has been limited on these formations to very scattered home sites with the greatest density in the Florida River drainage.

The east-west transitional area between the mountains and mesa lands consists of about six different geologic formations. They create the land forms from the southern drainage of Junction Creek and the Lightner Creek drainage on the west to the narrow ridges east of Durango to the Florida River. The formations include Mancos Shale, Point Lookout Sandstone, Cliff House Sandstone, Lewis Shale, and Kirkland Shale (Farmington Sandstone and Upper Shale Members).

The Mancos Shale is a dark-gray marine shale. The Point Lookout Sandstone is a light-gray to yellowish-gray sandstone with interbedded siltstone and shale in its lower part. Gray calcareous sandstone, argillaceous sandstone, mudstone and silty shale form the Cliff House Sandstone formation. The Lewis Shale is dark-gray clay shale containing thin sandstone beds near the top and rusty-weathering concentrations in the lower part. The Upper Shale Member of the Kirkland Formation is sandy shale and light-gray sandstone; the Farmington Sandstone is light-gray sandstone, with beds of greenish-gray shale. Development on these formations is very limited. Surficial deposits associated with these formations include landslide deposits, pediment gravels (sand and gravel deposits of glacial outwash often blanketed by loess; usually found at higher levels or as "caps" on mesas), glacial till deposits, and alluvial-colluvial deposits (a mixture of alluvial deposits and gravity derived slope wash deposits).

The remaining geologic formations in the Study Area have formed the Florida Mesa and the lower segments of the Florida and Animas Rivers. The northern area of Florida Mesa is the Animas Formation; most of the remaining areas are alluvial deposits from the Animas and Florida Rivers. Along the edges of the alluvium, and in intermittent drainages off of the Mesa, the San Jose, Nacimiento and Animas Formations occur. The Animas Formation is a dark vari-colored sandstone, shale, and conglomerate which contains abundant volcanis and arkosic detritus. Surficial deposits associated with the Animas Formation include alluvial colluvial deposits and some alluvial deposits. The alluvial formations of the Mesa have surficial deposits of pediment gravels with some colluvial deposits on the western edges.

Faults in the area are confined to the southeast area of Durango, and tend to run from the southwest to the northeast. La Platta County is in seismic zone two and is subject to moderate earthquake damage. Other identified geologic hazards include rock falls, debris fans (areas subject to wash from tributary streams), unstable and potentially unstable slopes, areas of high and moderate erosion potential, landslide areas, and slope failure complexes. These hazardous conditions have been responsible for preventing development of some otherwise desirable sites within the Study Area. Specific geologic hazard constraints for each area are presented in Figures 1 through 6.

The geologic features described above have been mapped and are available from U.S. Geological Survey and Colorado State Geological Survey, (References 1,2). These features are identified for the purpose of locating areas that might present special problems to certain types of development or use. Such areas should be evaluated on a more site specific basis.

SOILS

Soils information for the Study Area is available from the U.S. Soil Conservation Service (SCS) in preliminary form, (Reference 3). For evaluating soil suitabilities the Study Area is divided into the following subareas: Animas Valley north of Durango, Junction Creek, Lightner Creek, Florida Mesa and Florida River Valley. Within these areas only those soils currently or potentially facing development are discussed. The suitabilities of the soils in terms of septic tank absorption fields, groundwater table, flooding potential, slope, and shrink-swell characteristics are listed by subarea in Table 1.

Animas River Valley

Detailed soils information in the Animas Valley north of Trimble is currently not available; however, general soils associations are mapped. The Animas River Valley consists of loam soil and river wash flanked by rubble and rock outcrops. Loam makes up approximately sixty percent of the area, riverwash makes up approximately thirty percent of the area, and rubble and rock outcrop make up approximately ten percent of the area. The principal limiting features of soil in the Animas River Valley for development and the use of septic tank absorption fields are flood potential, shallow groundwater, and depth to bedrock. Specific soils of the valley are Werlow loam, Connerton loam, Humbarger loam, Pescar fine sandy loam, and Garza loam.

The predominant soil on the flood plain is the Werlow loam, a deep, somewhat poorly drained soil which formed in mixed alluvium. Typically, the surface layer is a pinkish-gray loam about five inches thick. The lower part of the surface horizon is typically a pale brown loam about

GEOLOGIC HAZARDS KEY*

A = SNOW AVALANCHE Areas subject to snow avalanches; arrows refer to direction of run.

S = SUBSIDENCE Areas of known or potential ground subsidence.

RF = ROCK FALL Areas below very steep slopes or cliffs subject to periodic rockfall.

F = FAULT Known fractures where displacement is recognized; La Plata County is in seismic zone two and is subject to moderate damage.**

DF = DEBRIS FAN Areas subject to torrential wash from tributary streams.

PUS = POTENTIALLY UNSTABLE SLOPES Slopes in equilibrium but subject to failure if disturbed improperly.

US = UNSTABLE SLOPES Slopes subject to failure (such as creep) but not known to be landslides.

SFC = SLOPE FAILURE COMPLEX Known areas of complex slope failure often associated with multiple landslides; arrows refer to direction of movement.

LS = LANDSLIDE Known areas of slope failure including rotational and translational slides, debris slides and rock avalanches; arrows refer to direction of movement.

MF = MUDFLOW Known areas of mudflows, debris flows and earth flows.

RT = RADIOACTIVE TAILINGS Known areas of mill tailings which are radioactive.

GEOLOGIC CONTRAINTS

HEP = HIGH EROSION POTENTIAL Areas subject to a high rate of soil erosion; requires care in land-use planning.

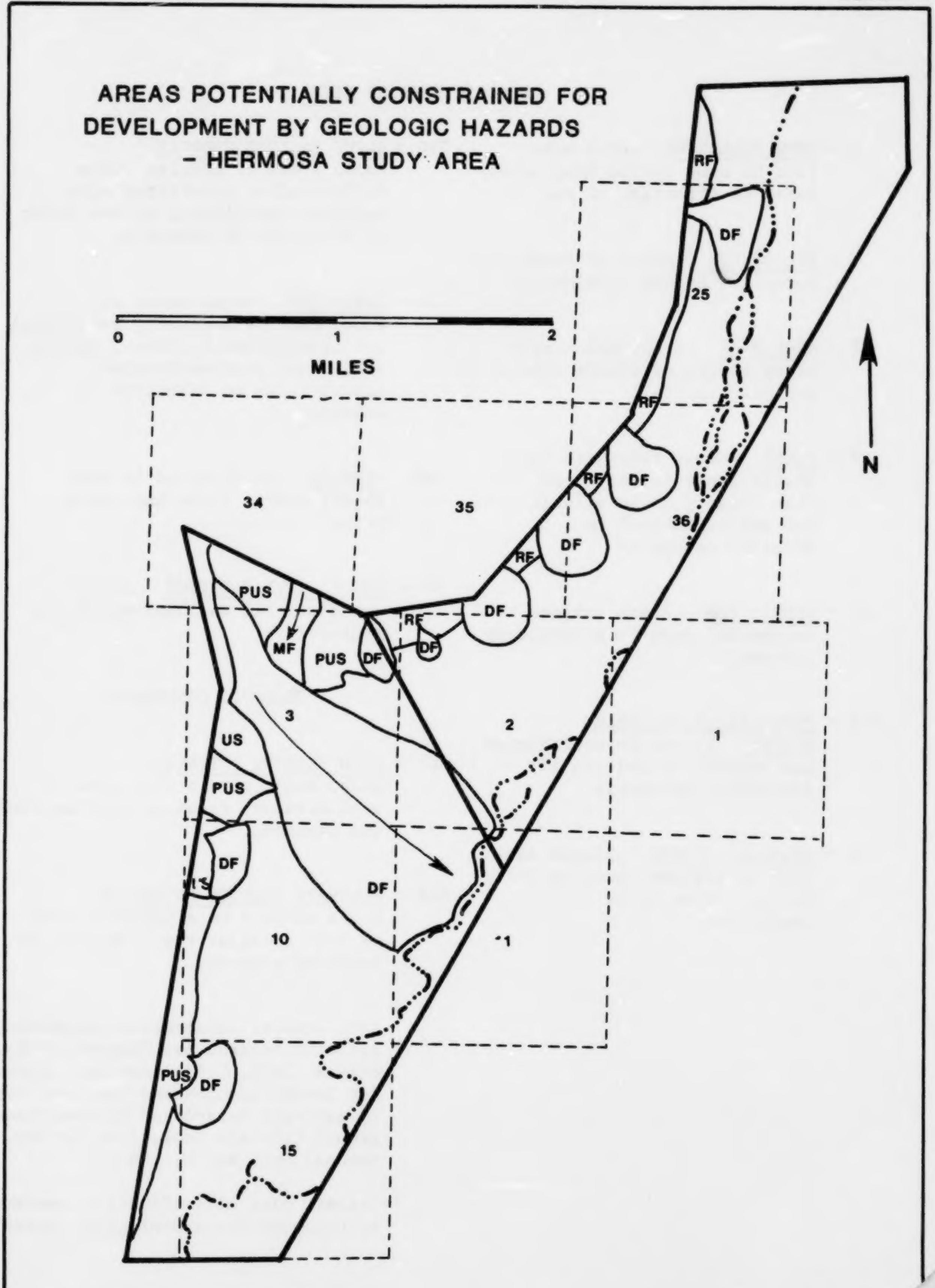
MEP = MODERATE EROSION POTENTIAL Areas subject to a moderate rate of soil erosion; requires care in land-use planning.

---

*For general information concerning geologic hazards see "Rogers, W.P., and others, 1974, Guidelines and criteria for identification and land-use controls of geologic hazard and mineral resource areas" Colorado Geological Survey, Special Pub. No. 6, 146 p.

**Seismic risk classification recommended by Colorado State Geological Survey.

FIGURE 1

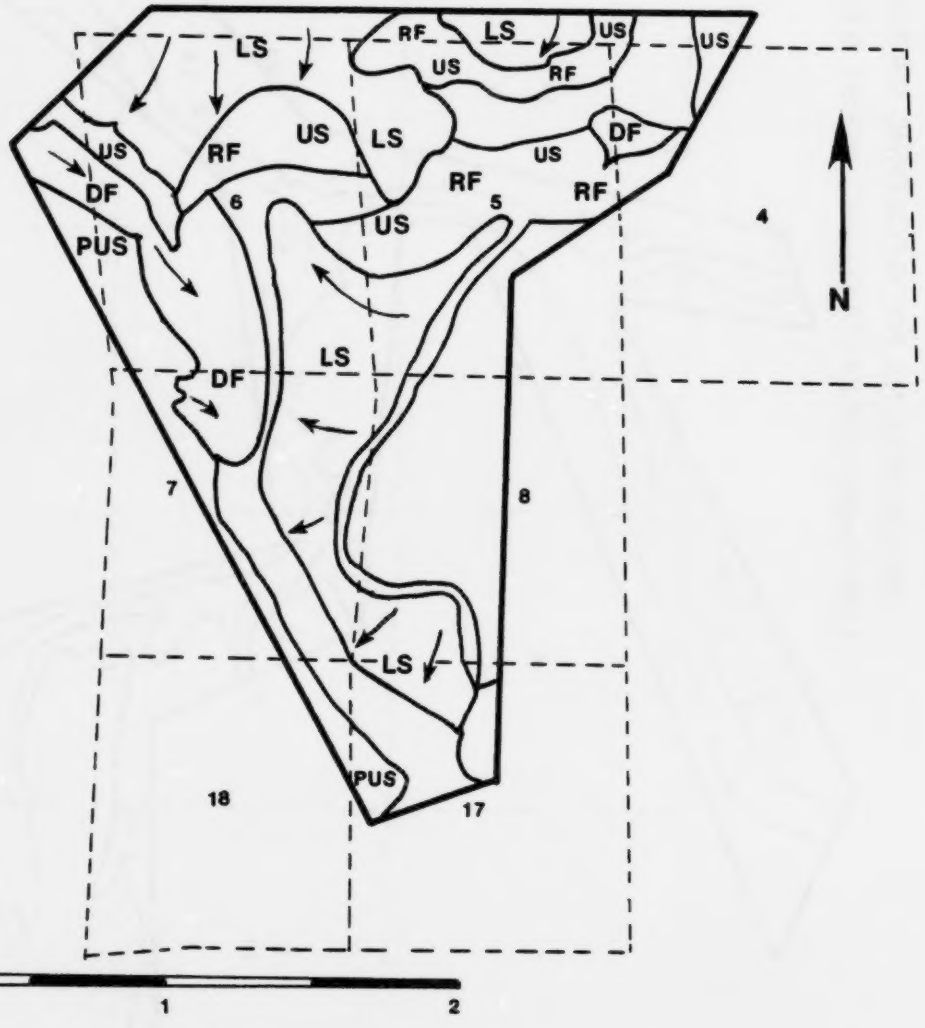


AREAS POTENTIALLY CONSTRAINED FOR DEVELOPMENT BY GEOLOGIC HAZARDS - HERMOSA STUDY AREA

0
1
2
MILES
N
RF
DF
25
RF
RF
DF
36
34
35
RF
DF
DF
RF
PUS
DF
MF
PUS
DF
3
2
1
US
PUS
DF
US
DF
10
11
PUS
DF
15

FIGURE 2

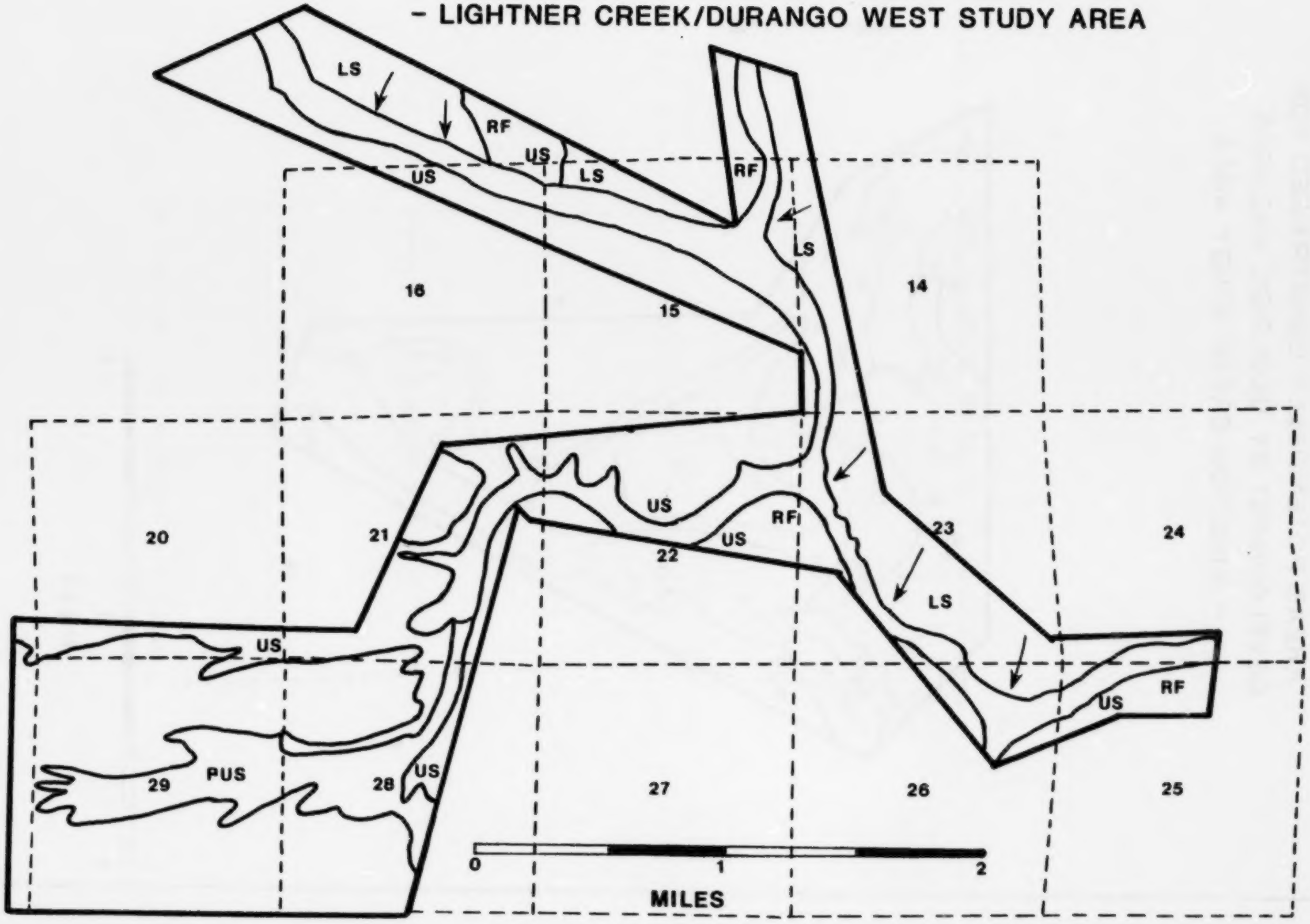
AREAS POTENTIALLY CONSTRAINED FOR DEVELOPMENT BY GEOLOGIC HAZARDS - JUNCTION CREEK STUDY AREA



LS
RF
LS
US
US
US
RF
US
LS
DF
US
RF
US
RF
LS
DF
US
RF
5
RF
6
DF
PUS
US
4
N
LS
DF
7
8
LS
PUS
18
17
0
1
2
MILES

FIGURE 3

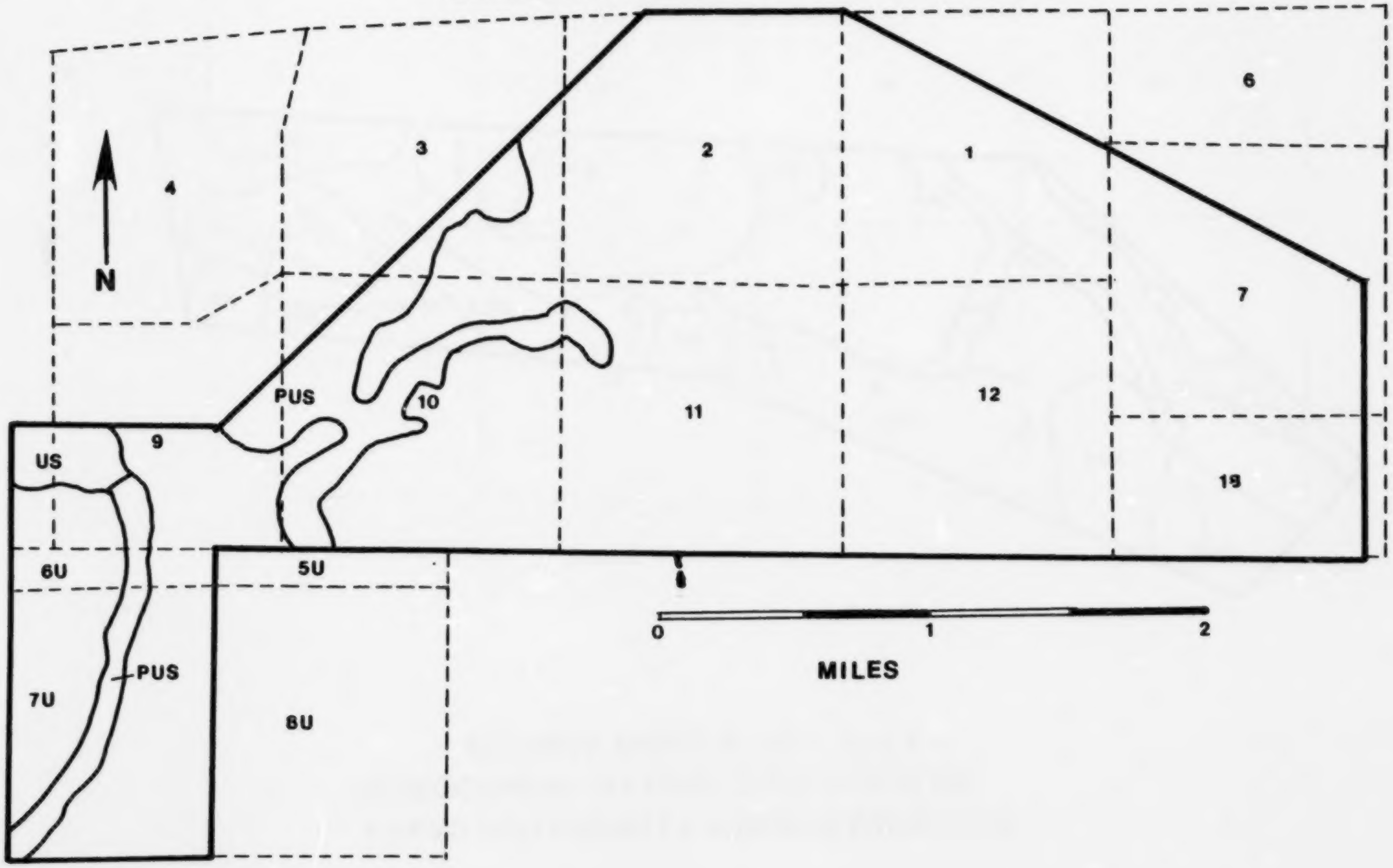
AREAS POTENTIALLY CONSTRAINED FOR DEVELOPMENT BY GEOLOGIC HAZARDS - LIGHTNER CREEK/DURANGO WEST STUDY AREA


LS
RF
US
US
LS
RF
LS
16
15
14
US
RF
US
20
21
22
23
24
LS
US
US
RF
US
29
PUS
28
27
26
25
0
1
2
MILES

A-12

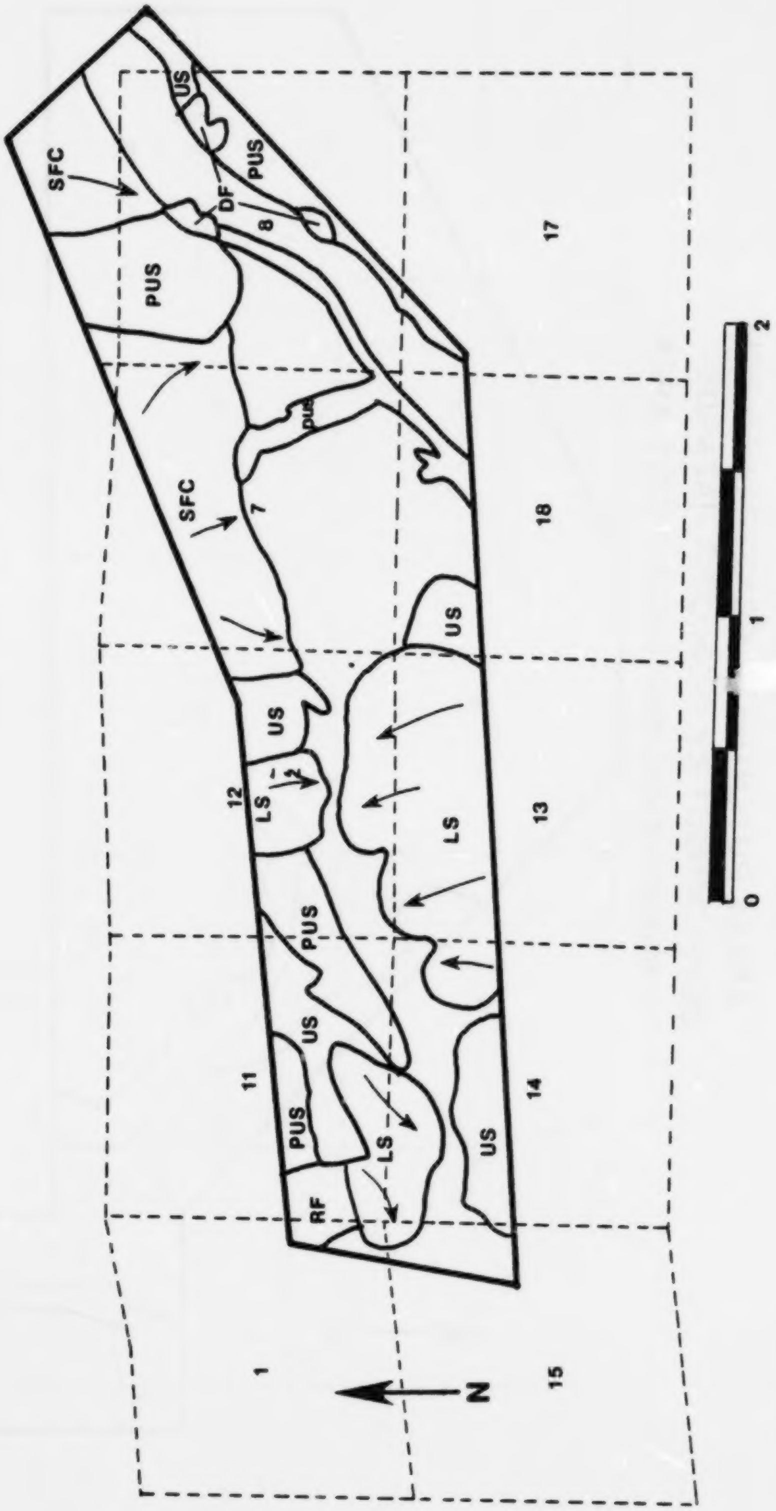
FIGURE 4

AREAS POTENTIALLY CONSTRAINED FOR
DEVELOPMENT BY GEOLOGIC HAZARDS
- GRANDVIEW/LOMA LINDA STUDY AREA


6
4
3
2
1
N
7
PUS
10
12
11
9
US
18
6U
5U
0
1
2
MILES
PUS
7U
8U

ENGINEERING-SCIENCE

FIGURE 5


SFC
US
PUS
DF
8
17
PUS
SFC
7
18
US
US
LS
2
12
LS
13
PUS
US
11
PUS
LS
RF
US
14
1
N
15
0
1
2
MILES

AREAS POTENTIALLY CONSTRAINED FOR DEVELOPMENT BY GEOLOGIC HAZARDS - FLORIDA ROAD STUDY AREA

AREAS POTENTIALLY CONSTRAINED FOR DEVELOPMENT BY GEOLOGIC HAZARDS - WEST ANIMAS STUDY AREA

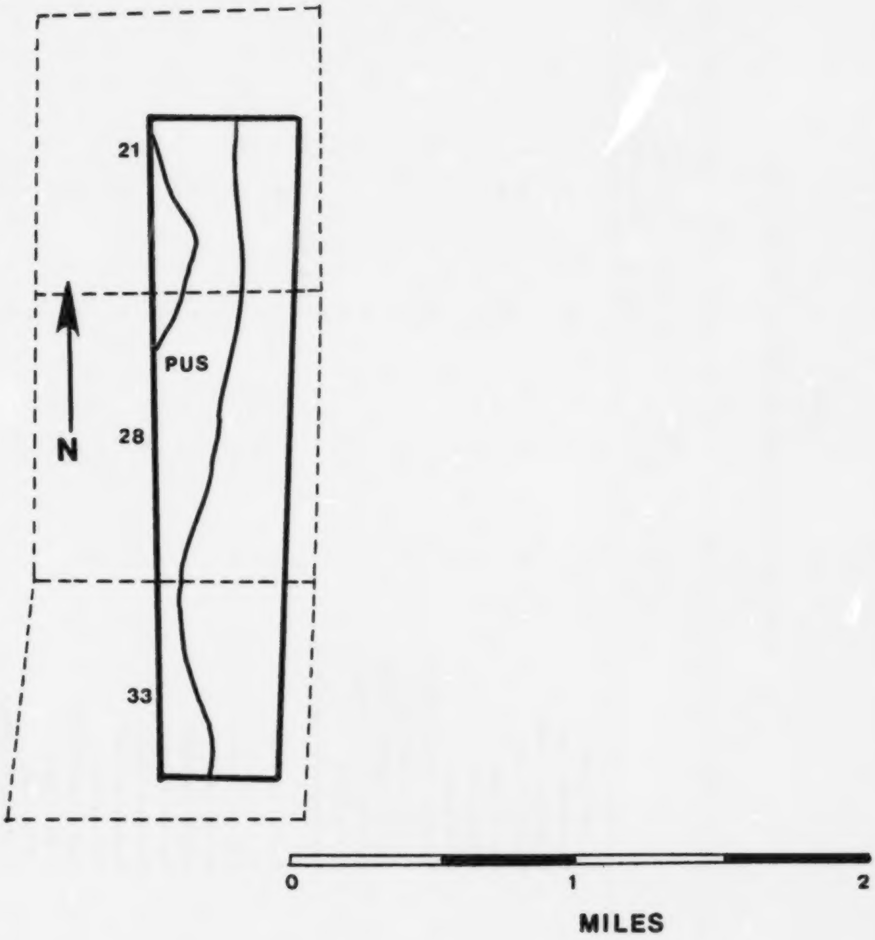

21
PUS
28
33
N
0
1
2
MILES

TABLE 1

SOIL LIMITATIONS AND DEVELOPMENT CAPABILITIES

Soil		Floods Occur	High Water Table	Excessive Slope	Slow Permeability	Shallow Bedrock	Excessive Shrink-Swell
Animas River Valley (Includes Hermosa & West Animas Areas)	Werlow Loam	P	P				
	Connerton Loam			F	H		
	Humbarger Loam		P				
	Pescar Loam	P	P		H		
	Garza Loam			P	H		
	Fluvaquent	P	P				
	Riverwash	P	P				
	Haploborolls Rubble			P			
	Fortwingate-Rock			P		P	
	Garza-Clayburn Rock						
	Goldvale-Fortwingate			P		P	P
	Valto Rock			P			
	Uinta-Leadville-Anvik			P			
Florida River Valley (Includes Florida Road Area)	Hesperus Loam				P		
	Werlow Loam	P	P				
	Pescar Loam	P	P		H		
	Piome Loam			F			F
	Goldvale Loam			F	F		H
	Nordic Loam			P			
	Alamosa Loam		P				
	Clayburn Loam			F	F		
	Fluvaquent	P	P				
	Carracas-Sanchez Outcrop			P	H	P	
	Valto Rock			P			
	Fortwingate-Rock			P		P	
Florida Mesa (Includes Grandview, Loma Linda, Air Park Area)	Falfa Loam				F		F
	Heldt Loam				F		F
	Werlow Loam	P	P				
	Midway Loam			P		P	P
	Big Blue Loam	P	P				
	Gaynor Clay				P	P	P
	Midway Rock			P	P	P	P

Soil		Floods Occur	High Water Table	Excessive Slope	Slow Permeability	Shallow Bedrock	Excessive Shrink-Swell
Lightner Creek	Pescar Loam	P	P		M		
	Fortwingate Loam			F		P	
	Anvik Loam			P			
	Nehar Loam						F
	Cold Creek Loam			P		P	
	Hesperus Loam				P		
	Midway Loam			P		P	P
	Goldvale Loam			P	F		M
	Carraces-Sanchez Outcrop			P	M	P	
	Fortwingate-Rock			P		P	
	Haploborolls-Rubble			P			
Junction Creek	Pescar Loam	P	P		M		
	Midway Loam			P		P	P
	Fortwingate Loam			F		P	
	Hesperus Loam				P		
	Connerton Loam			F	M		
	Big Blue Loam	P	P				
	Carraces-Sanchez Outcrop			P	M	P	
	Fortwingate-Rock			P		P	
	Haploborolls Rubble			P			
	Valto Rock			P			

Legend for Development Capability:

Poor (P):	The soil type requires intensive and costly engineering design measures to overcome physical limitations. For some types of facilities adequate engineering modifications may not be realistically feasible.
Fair (F):	The soil type requires some special engineering design considerations to accommodate facility installation. Most soil limitations can be resolved through appropriate design techniques.
Moderate (M):	The soil type requires compensating engineering designs to minimize soil limitations. Most constraints are readily resolved with standard techniques.

15 inches thick. The underlying material is a pinkish-gray loam stratified with loamy fine sand and fine sandy loam to 40 inches or more. Sand and gravel may underlie this soil at any depth below 40 inches. Werlow loam is used for agricultural land, pastureland, and rangeland. In addition, the soil has fair to good potential for supporting rangeland and openland wildlife. Permeability of Werlow loam is moderate to moderately rapid. Surface runoff is slow, and the erosion hazard is moderate. The available water capacity of the soil is high, and the water table in most places fluctuates between two to three feet from the surface during the spring and summer. The soil is subject to occasional flooding.

Connerton loam has a good potential for use as homesites and other developments. Expansion of the Durango area has resulted in urbanization of this soil. Slope and the rapid permeability rate are its primary limiting features. Foundations and sanitary facilities can and should be designed to overcome these limitations.

Humbarger loam, found on both alluvial fans and flood plains of major drainages, is a deep and moderately well-drained soil. It formed in moderately fine-textured alluvium. The surface layer is gray loam about 14 inches thick. The underlying material is dark grayish-brown loam to a depth of 60 inches or more. Humbarger loam is used mainly for irrigated crops, pasture, and range. Permeability is moderately slow to moderate. Available water capacity is high, and surface runoff is slow. Erosion hazard for this soil is slight. In general, Humbarger loam has poor potential for use as homesites and other developments. The main limitation of the soil is its spring season high water table. Construction of septic tanks and absorption fields might tend to jeopardize groundwater quality.

Also found on flood plains and terraces is the Pescar fine sandy loam. This deep, somewhat poorly drained soil formed in stratified calcareous mixed alluvium. Generally, the surface layer is light brownish-gray fine sandy loam about eight inches thick; the underlying layer is a light brownish-gray fine sandy loam about 12 inches thick. The substream is light brownish-gray very gravelly sand that extends to a depth of 60 inches or more. Pescar soil is used mainly for irrigated pasture and hayland and the soil is well suited for wildlife. Permeability of the Pescar fine sandy loam is moderate to rapid. Surface runoff is very slow and thus the erosion hazard is slight. Unlike other soils discussed, available water capacity is low. This soil has a fluctuating water table which is within 18 to 30 inches of the surface during the spring and summer, and is subject to frequent flooding from April through September. In general, the frequent flooding, seepage, and depth of the water table during spring and summer limit use of this soil for homesites and other urban developments. In order to overcome these limitations, intensive and costly engineering design and special measures may be required.

Garza loam is situated on mountain slopes and is generally a deep well-drained soil. It formed in alluvial and colluvial material. The upper part of the surface layer is grayish-brown loam about 20 inches thick. The underlying material is light brownish-gray cobbly loam that extends to 60 inches or more. This soil is used mainly for woodland, native pasture, and homesite development. Permeability of Garza loam is moderate and available water capacity is high. Surface runoff is moderate; thus, erosion hazard is light. The soil is suitable for homesites and other developments, unless the slope becomes a limiting factor. Compensating engineering designs and measures are required to minimize slope limitations when constructing roads and dwellings. Sealing methods are also required on Garza loam when constructing sewage lagoons to overcome the threat of seepage.

Intermingled with the loam soils in the flood plains are Fluvaquent soils and Riverwash. Both are somewhat poorly drained soils which have a high water table throughout the year and are prone to flooding. The Fluvaquent soils generally consist of gravelly or cobbly loam overlying sand and gravel at depths from five to twenty inches. These soils vary greatly from area to area. Riverwash consists of undifferentiated sand, gravel, and cobble. Fluvaquent soils can support some vegetation, but Riverwash supports practically none. Both Fluvaquent soils and Riverwash have poor potential for use as homesites or other developments. The high water table and flooding history make the use of septic tank and leach fields potential threats to groundwater and surface water quality.

The rubble land and rock-soil outcrops which flank the flood plain, terrace, and foothill areas consist of the Haploborolls rubble land complex, the Fortwingate-Rock outcrop complex, the Garza-Clayburn Rock outcrop, the Goldvale-Fortwingate-Valto outcrop association, and the Uinta-Leadville-Anvik association.

The Haploborolls rubble land complex is the most extensive soil-rock type in the Animas River Valley. The complex, found on mountain slopes, consists of shallow to deep, well-drained soils mixed with colluvial deposited boulders, stones, and cobble. This unit is used almost entirely for rangeland and wildlife. The complex has poor potential for use as homesites and other developments as a result of steep unstable slopes.

The Fortwingate-Rock outcrop complex consists of a moderately deep, well-drained soil and rock outcrop on moderately sloping to moderately steep mountain slopes. Typically, the surface of Fortwingate is covered with one to three inches of organic material. The surface is typically a dark-brown, stony, fine sandy loam about one inch thick. The lower portion of the surface horizon is generally a pinkish-gray, fine sandy loam about eight inches thick. The upper portion of the subsoil is typically a brown loam about 20 inches thick. The lower portion of the subsoil is typically a strong brown, stony, clay loam about ten inches thick. Sandstone bedrock usually occurs at a depth of 32 inches. The soil is suited for vegetation and wildlife. Permeability of the Fortwingate-Rock outcrop complex is moderately slow to slow. Surface runoff is moderate and erosion hazard is low. Available water is moderate. This soil complex has a poor potential for the development of homesites and other buildings. The primary soil limiting features are depth to bedrock and slope. Construction problems may be encountered when laying utility lines, sewage lines, and foundations.

The three soils complexes of the northern part of the Animas River Valley, the Goldvale-Fortwingate-Valto, the Garza-Clayburn Rock outcrop, and the Uinta-Leadville-Anvik complexes, all consist of mixtures of loam and rock. The soil complexes are found on steep mountain slopes and are generally well-drained.

The Goldvale-Fortwingate-Valto complex generally has a poor potential for homesite development. The Goldvale soil has a high shrink-swell potential, which makes it somewhat unsuitable for road and foundation construction. In addition, slow percolation of this soil limits the use of septic tanks and absorption fields. The Fortwingate and Valto soils also have poor potential for the development of homesites and other buildings primarily because of steep slopes and depth to bedrock. The nearness of bedrock to both of these soils makes seepage from septic tanks or lagoons a threat to groundwater quality.

The Garza-Clayburn Rock outcrop has fair potential for use as homesites and other developments. The main limitation in areas of this complex is slope, which is often too steep for the development of septic tanks and absorption fields.

The Uinta-Leadville-Anvik complex has poor potential for homesite construction and other development, with slope being the main limiting factor.

Florida River Valley

Generally, the soils of the Florida River Valley consist of loam and a small amount of Fluvaquent soils in the flood plain area, and rock outcrops at the flood plain's perimeter. Loam and Fluvaquents make up approximately eighty percent of the Study Area while the rock outcrops make up the remaining twenty percent.

Specific types of soil in the area are Hesperus loam, Werlow loam, Pescar fine sandy loam, Plome fine sandy loam, Goldvale very stony fine sandy loam, Nordic stony fine sandy loam, Alamosa loam, and Clayburn cobbly loam. Pescar fine sandy loam, Werlow loam, and Fluvaquents are discussed under the Animas River Valley. Nordic stony fine sandy loam and Alamosa loam exist in such insignificant quantities that these soils will only be described briefly.

Hesperus loam is a deep, dark colored, and well-drained soil located on gently sloping to moderately sloping mountain slopes, alluvial fans, and valley bottoms. It is formed in medium textured alluvium. Typically, the surface is a dark grayish-brown loam about thirteen inches thick. The top portion of the subsoil is typically a dark-gray clay loam about eight inches thick. The middle portion of the subsoil is typically a grayish-brown clay loam about thirteen inches thick. The substratum is typically a pale-brown sandy clay loam. The soil is used primarily for native rangeland, dry cropland, irrigated cropland, and homesites. Permeability is slow to moderate in this soil. Surface runoff is medium to rapid and the erosion hazard is slight. Available water capacity is high. Generally, Hesperus soil has a poor to fair potential for use as homesites and other developments. The slow percolation rate of some Hesperus loam may create potential pollution hazards to the groundwater if septic tanks and absorption fields are installed.

Nordic stony fine sandy loam is a deep, well-drained soil which is located on moderate to moderately steep slopes. It is formed from colluvium and alluvium derived from sandstone. Generally, the surface is covered with one to three inches of organic material. The surface layer is typically a very dark grayish-brown, stony, fine sandy loam about nineteen inches thick. The lower portion of the surface layer is a brown, stony, sandy loam of about twenty inches. The subsoil is typically a brown, stony, clay loam about twenty-five inches thick. The soil is used as woodlands and, in small areas, for homesite developments. Permeability of the soil is moderate. Surface runoff is slow and the erosion hazard is low. Available water of the soil is high. This Nordic loam has a poor potential for the construction of homesites and other development. The limiting factors are slope and the presence of large stones. These limitations make the soil unsuitable for the development of absorption fields and the construction of septic tanks.

Goldvale very stony fine sandy loam is a deep, well-drained soil found on steep to very steep mountain slopes and sides of alluvial valleys. It is formed from colluvial-alluvial material derived from interbedded sandstone and shale. Typically, the surface is covered by a zero to four inch thick layer of organic material. The surface layer is a reddish-gray, very stony, fine sandy loam about three inches thick. The middle portion of the surface is pinkish-gray, very stony, fine sandy loam about ten inches thick. The lower portion of the surface is mixed light-brown and pinkish-gray, stony, sandy clay loam about four inches thick. The upper portion of the subsoil is a mixed light-brown and pinkish-gray, stony, sandy clay loam about four inches thick. The middle portion of the subsoil is a reddish-brown clay about fourteen inches thick. The lower portion of the subsoil is mixed reddish-brown and yellowish-brown stony clay. Most of this soil unit is used in woodland or homesite development. Permeability is moderate. Surface runoff is medium to rapid and the erosion hazard is low. Available water capacity is high. Limiting features of the soil for residential development are its shrink-swell potential and slope. In addition, percolation might tend to be slow. Septic tank and absorption field construction should be designed to overcome the limiting features.

Plome fine sandy loam is located on mountain slopes. A deep, well-drained soil, Plome formed in eolian sediments. Generally, the dark grayish-brown surface layer is about four inches thick. The upper part of the subsoil is light reddish-brown sandy loam about fourteen inches thick. The substratum is reddish-brown sandy clay loam that extends to a depth of sixty inches or more. This soil is used mainly for irrigated crops, dry crops, woodland and native pasture. Permeability is moderately slow. Surface runoff is moderate and erosion hazard is slight. Available water capacity of the soil is high. The Plome soil has fair potential for use as homesites and other developments. The soil's primary limitations in this regard are its high shrink-swell potential, slope, and inability to support a load. The limitations are fairly readily overcome by use of engineering measures, and septic tanks and absorption fields can be accommodated.

Clayburn and Alamosa cobbly loams occupy only a small part of this segment. Clayburn soil, found on mountain slopes and toe slopes, has moderately slow permeability, and has generally a fair potential for use as homesites and other developments. The limiting factor for septic tank absorption fields is slope. Alamosa soil is generally found on level or nearly level areas. It has moderately slow to slow permeability, and generally has a poor potential for use as homesites. The primary limiting factor is the high water table. Septic tanks and absorption fields have the potential for jeopardizing groundwater quality when placed in this soil.

The soil-rock outcrops which border the valley are the Carracas-Sanchez, Valto, and Fortwingate. Additionally, rock outcrops exist. The Fortwingate-Rock outcrop complex has been described under the Animas River Valley.

The Carracas-Sanchez complex consists of well-drained soils on gently sloping to steep mountain slopes. They are formed in residium overlying interbedded sandstone and shale. The Carracas soil has a surface covered with one to three inches of organic material. Typically the surface is a dark gray-brown loam about three inches thick. The underlying material is a yellow-brown clay loam about six inches thick. The Sanches soil has a brown, stony, sandy clay loam surface about five inches thick. The subsoil is a dark grayish-brown clay loam about ten inches thick. Sandstone bedrock usually occurs with seventeen inches of the surface. Permeability is moderate, down to bedrock. Surface runoff varies from rapid to very rapid, and erosion hazard is moderate. Available water of the soil is low. This complex has a poor potential for homesite and other development. Depth to bedrock is the primary limiting feature. This factor plus steep slopes make the soils unsuitable for the construction of septic tanks and absorption fields. On areas where these soils occur near drainages, seepage from septic tanks may cause groundwater quality problems.

The Valto-Rock outcrop complex has shallow, well-drained soils on mountain slopes and ridges. It is formed in material weathered from sandstone. Typically, the surface layer of Valto soils is covered by a two to four inch thick organic layer. The surface layer is a dark reddish-gray, stony, fine sandy loam about two inches thick. The upper part of the underlying material is a light reddish-brown, very stony, fine sandy loam about ten inches thick. The lower portion of the underlying material is fractured sandstone bedrock. This complex is used primarily for woodland and, in small areas, for homesite development. Permeability is moderate to moderately rapid. Runoff is moderately rapid and the erosion hazard is low. Available water is low. The Valto-Rock outcrop complex has a poor potential for the development of homesites and other buildings. The primary limiting factors are the soil's slope and possible seepage into groundwater. Thus, septic tanks and absorption fields may be potential threats to groundwater quality.

Rock outcrops have shallow soils too variable to rate. Vegetation is sparse and the rock unit has a poor potential for use as homesites and other developments. Its main limitations are lack of soil material, steepness of slopes and general rocky characteristics. No septic tanks or absorption fields could operate in this type of outcrop.

The Florida Mesa

The Mesa generally consists of loam, clay and clayey loam soils with some small areas of rock outcrop. The specific soils of the area are Falfa loam, Heldt silty loam, Werlow loam, Midway clay loam, Big Blue clay loam, and Gaynor clay. Werlow loam has been described under the Animas River Valley.

Falfa loam is a deep, well-drained soil on mesa tops. It formed from eolian materials that originated from redbed deposits. Typically, the surface layer is reddish-gray loam about six inches thick. The upper part of the subsoil is reddish-brown clay loam about five inches thick. The middle part of the subsoil is reddish-brown clay about twenty inches thick. The lower part of the subsoil is reddish-brown clay about twenty five inches thick. The substratum is pink loam to a depth of sixty inches or more. This soil is used mainly for irrigated crops, nonirrigated crops, and range. Permeability is slow and available water capacity of the soil is high. Surface runoff is moderate and erosion hazard is moderate. Incorporating residues into and on the surface helps reduce erosion. The Falfa soil has a fair potential for use as homesites and other urban developments. The soil's main limitations are the clayey subsoil with high shrink-swell potential and its slow permeability. Foundations, septic tank absorption fields, roads and streets must be designed to overcome these limitations.

Heldt silty clay loam is a deep, well-drained soil usually located on valley slopes and upland valleys. This soil formed in fine textured alluvium from shale hills. Typically, the surface is light olive-brown, silty clay loam about eight inches thick. The subsoil is a light olive-brown, heavy silty clay about twenty inches thick. The substratum is a light yellowish-brown, silty clay to a depth of sixty inches or more. In some areas on the steeper slopes, these horizons may be thinner. This soil is used mainly for irrigated and nonirrigated crop land. Permeability of the Heldt soil is very slow. Surface runoff is moderate and erosion hazard is moderate. Incorporating residues into the soil controls erosion. Heldt soil has a fair potential for use as homesites and other development. Slow permeability, clay layers, and high shrink-swell potential are the primary limitations. Septic tank absorption fields, foundations, and roadbeds must be designed to overcome these limitations.

Midway clay loam is a shallow, well-drained soil located on ridges and hills in shale bedrock uplands. It formed in residium on shale. Typically, the surface layer is light brownish-gray clay about three inches thick. The underlying material is light gray clay that overlies soft shale at about eight to twenty inches. Permeability is very slow. Surface runoff is rapid and erosion hazard is high. Vegetation growth is necessary on these soils to reduce erosion. The Midway soil has a poor potential for use as homesites and other developments. The shallow depth of bedrock, steep slopes, and high shrink-swell potential of this soil are its main limitations. Foundations, septic tank absorption fields, and roads need to be designed to overcome these limitations.

Big Blue clay loam is a deep, poorly-drained soil located on low terraces and valley bottoms. It formed in fine textured alluvium from shale. Generally, the upper part of the surface layer is dark grayish-brown clay loam about eight inches thick. The lower part of the surface layer is dark grayish-brown silty clay about eight inches thick. The subsoil is gray silty clay about ten inches thick. The substratum is gray calcareous silty clay to sixty inches or more. Gleying and mottles are common in the subsoil and substratum. The soil is used mainly for irrigated pasture and rangeland, and wetland wildlife utilize these soils. Permeability of Big Blue soil is slow. Available water capacity is high. Surface runoff is slow and erosion hazard is slight. This soil has a fluctuating water table during most of the year and is subject to occasional flooding during spring and summer months. The Big Blue soil has a poor potential for use as homesites or other developments. The soil's main limitation is its susceptibility to occasional flooding. Intensive and costly engineering design measures are needed to overcome this limitation in order to develop septic tank absorption fields.

Gaynor clay, a moderately deep, well-drained soil, is located on slopes of shale hills. It formed in residium from shale. Typically, the upper part of the surface layer is gray clay about three inches thick. The lower part of the surface layer is dark clay about three inches thick. The underlying material is dark gray clay overlying shale bedrock between depths of twenty to forty inches. The soil is used mainly for irrigated pasture and hay, with some range land use. Permeability is very slow. Available water capacity is moderate. Surface runoff is moderate and erosion hazard is high. Pasture and hay land management as well as proper irrigation methods are necessary to minimize erosion. The Gaynor soil has a poor potential for use as homesites or other community developments. The main limitations of this soil are depth to bedrock and high shrink-swell characteristics. Major modifications are needed in the design of septic tank absorption fields, foundations, and road beds to overcome these limitations.

The main rock outcrop of the area is the Midway Rock outcrop complex, which consists of shallow well-drained soil on shaley foothills and shale and sandstone rock outcrops. Typically the surface area is light brownish-gray about three inches thick. The underlying material is light gray clay that overlies soft shale at about eight to twenty inches. The soil is used primarily for range. Permeability is very slow. Available water capacity is low. Surface runoff is rapid and erosion hazard is high. Vegetation growth and the incorporation of proper grazing use can help minimize erosion problems. The Midway Rock outcrop complex has a poor potential for use as homesites and other developments. The shallow depth to bedrock, slope, and shrink-swell potential of this soil are its main limitations. Septic tank absorption fields, foundations, and roads need to be designed to overcome the limitations.

Lightner Creek

The Lightner Creek Valley consists of loamy soils flanked by soil-rock outcrops. The loam soils make up approximately sixty-five percent of the area, while the soil-rock outcrops make up the other thirty-five percent.

Specific loam soils of the area are the Pescar fine sandy loam, Fortwingate stony fine sandy loam, Anvik loam, Nehar stony fine sandy loam, Cold Creek Variant stony fine sandy loam, Hesperus loam, Goldvale very stony fine sandy loam and Midway clay loam. The Pescar soil has been discussed under the Animas River Valley, Hesperus and Goldvale soils have been discussed under the Florida River Valley, and Midway clay loam has been discussed under the Florida Mesa.

Fortwingate stony fine sandy loam is a moderately deep, well-drained soil located on gently sloping to very sloping mountain slopes.

It is formed in mixed facial material, sandstone, and loess. Typically, the surface is covered with one to three inches of organic material. The surface is generally a dark-brown, stony, fine sandy loam about one inch thick. The lower portion of the surface horizon is typically a pinkish-gray, fine sandy loam about eight inches thick. The upper portion of the subsoil is typically a strong-brown, stony, clay loam about ten inches thick. Sandstone bedrock usually occurs at a depth of thirty-two inches. This soil is used as woodland and, in small areas, for homesite development. Permeability is moderately slow to slow. Available water is moderate. Surface runoff is moderate and erosion hazard is low. This soil has a poor potential for the development of homesites and other buildings. The primary soil limiting features are the shallow depth to bedrock and slope. Septic tanks and absorption fields must be designed to avoid seepage and overcome slope limitations.

Anvik loam, a deep, well-drained soil, is found on moderately steep to steep mountain slopes. It is formed in colluvial-alluvial material derived from sandstone and shale. Typically, the surface is covered by a two to four inch thick layer of organic material. The surface layer is a dark-brown loam about thirteen inches thick. The lower portion of the surface horizon is a light yellowish-brown sandy loam about eight inches thick. The upper portion of the subsoil is a light yellowish-brown and brown sandy clay loam about four inches thick. The middle portion of the subsoil is a brown sandy clay loam about thirteen inches thick. The lower portion of the subsoil is a brown sandy loam over sixty inches in depth. This soil is used for woodland, and in small areas for homesite developments. Permeability of the Anvik soil is moderate. Surface runoff is slow and erosion hazard is slight. Available water capacity of the soil is high. Anvik soil has a poor potential for homesite construction and other development. Slope is the primary limiting feature.

Nehar stony fine sandy loam is a deep, well-drained soil found on terraces along major drainages. It formed in cobbly and stony glacial outwash material. Typically, the upper part of the surface is pink, stony, fine sandy loam about two inches thick. The lower part of the surface layer is light reddish-brown, stony, fine sandy loam about five inches thick. The subsoil is reddish-brown, stony, clay loam about twelve inches thick. The substratum is very cobbly and stony sandy loam extending to sixty inches or more. Permeability is slow to moderately slow. Available water capacity is moderate. Surface runoff is slow and erosion hazard is slight. The Nehar soil has fair potential for use as homesites and other developments. The soil's primary limitations are a moderate shrink-swell potential and an inability to support a load. Septic tank absorption fields, foundations, and streets need to be designed to overcome these limitations.

Cold Creek variant stony fine sandy loam is a deep, well-drained soil found on mountain slopes. It formed in stony colluvial material composed mostly of sandstone. Typically, the surface is covered by a two or three inch layer of organic material. The surface layer is typically grayish-brown, very stony, fine sandy loam about two inches thick. The lower part of the surface is a very pale-brown, stony, fine sandy loam about 22 inches thick. The upper part of the subsoil is a pale-brown, extremely stony, clay loam about eight inches thick. The lower part of the subsoil is a brownish-yellow, extremely stony, clay loam about ten inches thick. The substratum is a very stony clay loam about eight inches thick. This is underlain by shale and sandstone at depths ranging from forty to sixty inches or more. The soil is used mostly for wildlife habitat, woodland, and range. Permeability of Cold Creek variant soil is moderately slow. Available water capacity is low. Surface runoff is moderate and erosion hazard is moderate. The growth of vegetation can reduce erosion problems. Cold Creek variant soil is not especially suited for homesite development. Steep slope, rockiness, and hazards of landslides are limiting factors. In addition, shallow depth to bedrock makes the soil unsuitable to septic tank and absorption field construction.

The specific soil-rock outcrop complexes of the area are the Carracas-Sanchez complex, the Fortwingate-Rock outcrop complex, and the Haploborolls rubble land complex. The Carracas-Sanchez complex is described under the Florida River Valley; Fortwingate-Rock outcrop complex and Haploborolls rubble land complex are described under the Animas River Valley.

Junction Creek

The valley consists of loam bordered by soil-rock outcrops and badland. Loam makes up approximately sixty percent of the area, while soil-rock outcrops and badland make up the other forty percent.

Specific types of loam in the area include Pescar fine sandy loam, Midway clay loam, Fortwingate stony fine sandy loam, Hesperus loam, Connerton loam, and Big Blue clay loam. The Pescar and Connerton soils are described in the Animas River section; Hesperus soil is discussed in the Florida River Valley section; Midway and Big Blue soils are discussed in the Florida Mesa section; and Fortwingate soil is discussed in the Lightner Creek section.

Soil-rock outcrop complexes in the area are Carracas-Sanchez complex, Haploborolls rubble land complex, Fortwingate-Rock outcrop complex, and Valto-Rock outcrop complex. The Fortwingate and Haploborolls complexes are discussed in the Animas River section; the Carracas-Sanchez and Valto complexes are discussed in the Florida River Valley section.

Badland consists of steep and very steep barren land dissected by many intermittent drainage channels that have entrenched into the Mancos shale. About ninety percent or more of this unit is unvegetated. Onsite investigations are needed for more detailed interpretations to determine use and planning at proposed sites.

FLOOD PLAIN

The U.S. Army Corps of Engineers has prepared three flood plain information reports for the Animas River and selected tributaries within the EIS/201 Study Area, (References 5, 6). Tributaries of the Animas River for which the designated 100- and 500-year flood plains are mapped include Junction Creek, Hermosa Creek, Dry Gulch Creek, and Lightner Creek. The Animas River flood plain is mapped from Baker's Bridge to the La Posta Road Bridge below Durango. One hundred year flood plains for the Study Areas are shown in Figures 4.7 through 4.11 in the EIS. The Florida Road area does not include the flood plain of any of these waterways. Flood plain data are not available for the Florida River. However, the Florida River's flow is regulated by Lemon Reservoir, located about fourteen miles (22.5 km) northeast of Durango just outside the Study Area. The reservoir is approximately one-half mile (0.8 km) wide and three miles (4.8 km) long with a capacity of 40,000 acre-feet (4.9×10^7 cubic meters). Runoff from the upper drainage area is stored, and regulated releases provide irrigation water below the impoundment as well as municipal and industrial water for Durango. The facility also provides fish and wildlife habitat, recreational opportunities and flood control.

The Animas River and its tributaries have relatively small flood carrying capacities. However, high volume/velocity flows and floating debris that have caused relatively minor floods have resulted in substantial property damage. This has probably occurred because much of the development within the narrow Animas Valley has been on the flood plain. Development in flood plains can potentially restrict flood flows, increase water velocity, alter flood plain boundaries and contribute to property losses. Flooding of treatment plants, interceptor sewers, collection lines, and on-site sewage disposal facilities can cause an interruption in treatment of wastewater and create public health hazards. The earliest recorded flood on the Animas River occurred in 1884. Subsequent large floods occurred in 1896, 1909, 1911, 1927, 1937, 1941, 1946, 1949, 1970, 1972, and 1973. The flood on October 5, 1911, is the most severe recorded in the area. During that flood event, a peak flow of 25,000 cubic feet per second was recorded at the Durango stream gage. Tributary flows were also high during that flood. Major snowmelt floods occurred in 1941 and 1949 in the Animas River, while snowmelt floods on Hermosa Creek occurred in 1920 and 1941. A major flood resulted from a rain storm on melting snow in June of 1927, when the peak flow in the Animas River reached 20,000 cubic feet per second.

VEGETATION

Vegetation in the Rocky Mountain region is influenced by elevation, exposure, temperature, soils, topography, and land use. For purposes of this EIS, broad general vegetation units will be separated using altitude variation. This approach will allow an identification of vegetation in horizontal zones. Within each zone smaller subunits of vegetation can be identified and their components inventoried.

The Durango 201/EIS Study Area ranges in elevation from about 6,400 feet in the Animas Valley south of Durango to about 8,800 feet. The principal vegetation communities of the Study Area include ponderosa pine forest, pinyon-juniper woodland, mountain shrub, sagebrush, riparian woodland, and croplands.

Vegetation inventories have been conducted in relationship with the Animas-La Plata Project. These inventories cover the plant communities which are common to this EIS/201 Study. The large variations in elevation, topography, exposure, and temperature have produced a large number of habitats suitable for many different plant species. Vegetation studies in the Study Area indicate about 557 species present. These plants are listed in Table 2.

Well-developed, mature and comparatively undisturbed Ponderosa pine forest is an open forest with an understory of shrubs and herbs. Gambel's oak is the dominant shrub associated with this stand type. This forest provides the bulk of deer and elk habitat and is highly important for wild turkeys. Some herbaceous parks occur in this zone in the valley bottoms.

Below the Ponderosa pine forest is the more open pinyon-juniper woodland. On the dryer Ponderosa pine sites the pinyon-juniper will integrate in higher elevations while on moister sites the Ponderosa pine will integrate down. On deeper soils the pinyon pine dominates the stand while on steeper slopes and rocky soils the juniper component dominates. There is usually a shrub layer of Gambel's oak on higher soils or mountain mahogany and other shrubs on rocky soils. The mixed-browse understory is a major big game food supply and range.

The mountain shrub consists of two distinct plant communities in southwest Colorado. On areas with heavy, poorly drained soil, Gambel's oak dominates, while on lighter, better drained soils and rocky soils mountain mahogany dominates.

Sagebrush is scattered through the area and is found in close association with all plant communities below 9,500 feet. It often

TABLE 2

PLANTS OF THE STUDY AREA

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Abies concolor	White fir	T	D	X	X					
Abronia fragrans	Sand verbena	F	P			X	X	X	X	
Acer glabrum	Rocky Mountain maple	T	P	X	X					
Acer grandidentatum	Big-toothed maple	T	R		X					X
Acer negundo	Boxelder	T	A	X	X	X	X	X		X
Achillea lanulosa	Yarrow	F	A	X		X	X	X		
Achillea millefolium	Yarrow	F	P	X		X	X	X		
Actinea acaulis	Pinque	H	A			X	X	X	X	
Actinea richardsoni	Pinque	H	A			X	X	X	X	
Agoseris aurantiaca	Mountain-dandelion	F	P	X	X	X	X			
Agoseris glauca	Mountain-dandelion	F	P	X	X		X	X		
Agropyron cristatum	Crested wheatgrass	G	A				X	X	X	X
Agropyron intermedium	Intermediate wheatgrass	G	P				X	X	X	
Agropyron pseudorepens	False quackgrass	G	R	X		X	X	X	X	
Agropyron repens	Quackgrass	G	R						X	X
Agropyron smithii	Western wheatgrass	G	A	X	X	X	X	X	X	
Agropyron trachycaulum	Slender wheatgrass	G	A	X		X	X	X	X	
Agrostis alba	Red top	G	P			X	X	X	X	X
Aletes macdougali		F	R					X	X	
Allium acuminatum	Wild onion	F	P	X		X	X	X		
Allium geyeri	Wild onion	F	C	X	X	X				

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Allium textile	Wild onion	F	P	X		X	X	X	X	
Alnus tenuifolia	Thin-leaf alder	T	C	X	X	X	X			X
Alyssum alyssoides	Alyssum	F	A	X		X	X	X	X	
Amaranthus graecizans	Pigweed	F	C			X	X	X	X	
Amaranthus retroflexus	Pigweed	F	P			X	X	X	X	
Ambrosia coronopifolia	Ragweed	F	R			X	X	X		
Amelanchier alnifolia	Serviceberry	S	C	X	X	X	X			
Anaphalis margaritacea	Pearly everlasting	F	R	X	X					
Andropogon gerardi	Big bluestem	G	R						X	
Andropogon scoparius	Little bluestem	G	R					X	X	
Androsace septentrionalis	Rock jasmine	F	A	X	X					
Androstephium brefiflorum	Funnellily	F	R			X	X	X		
Antennaria dimorpha	Pussytoes	F	P	X	X	X				
Antennaria parvifolia	Pussytoes	F	A	X	X					
Antennaria rosea	Rosy pussytoes	F	P	X	X					
Apocynum androsaemifolium	Dog bane	F	A	X						
Apocynum cannabinum	Dog bane	F	P	X	X	X	X	X		
Aquilegia elegantula	Western red columbine	F	C							

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Arabis divaricarpa	Rockcress	F	C	X		X	X	X		
Arabis fendleri	Rockcress	F	P	X		X	X			
Arabis hirsuta	Rockcress	F	C	X		X	X	X		
Arabis holboellii	Rockcress	F	C	X	X	X	X			
Arabis lignifera	Rockcress	F	P	X		X	X			
Arabis pulchra	Rockcress	F	R			X	X	X		
Arabis selbyi	Rockcress	F	P	X		X	X			
Arceuthobium campylopodum	Dwarf mistletoe	F	R		X					
Arceuthobium vaginatum	Dwarf mistletoe	F	P	X	X					
Arenaria congesta	Sandwort	F	R	X		X	X			
Argemone intermedia	Prickly poppy	F	P			X	X			
Aristida fendleriana	Fendler threeawn	G	P	X		X	X	X	X	
Aristida longiseta	Red threeawn	G	A						X	X
Artemisia cana	Silver sagebrush	S	A			X	X	X		
Artemisia carruthi	Carruth sagebrush	H	P	X	X					
Artemisia dracunculus	Green sagewort	F	P	X		X	X	X		
Artemisia frigida	Fringed sagebrush	H	A			X	X	X		
Artemisia ludoviciana	Common wormwood	F	C	X		X	X	X		
Artemisia nova	Black sagebrush	S	P					X		
Artemisia spinescens	Bud sagebrush	S	R					X	X	
Artemisia tridentata	Big sagebrush	S	D	X		X	X	X		
Asclepias capricornu	Milk weed	F	C	X						
Asclepias speciosa	Giant milkweed	F	C	X		X				

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Asclepias verticillata	Whorled milkweed	F	R	X						
Asparagus officinalis	Asparagus	F	P	X		X	X	X	X	X
Aster arenosus	Aster	F	P					X	X	
Aster bigelovii	Aster	F	P	X	X	X	X			
Aster falcatus	White aster	F	P			X	X	X		
Aster glaucodes	Aster	F	P	X	X	X				
Astragalus bisulcatus	Milkvetch	F	R				X	X	X	
Astragalus calycosus	Matted milkvetch	F	R					X		
Astragalus confertiflorus	Blue poisonvetch	F	R				X	X	X	
Astragalus flexuosus	Vetch	F	R	X		X	X	X	X	
Astragalus drummondii	Vetch	F	C				X	X	X	
Astragalus gracilis	Milkvetch	F	R					X	X	
Astragalus lentiginosus	Specklepod loco	F	P					X		
Astragalus lonchocarpus	Milkvetch	F	C				X	X	X	
Astragalus missouriensis	Missouri milkvetch	F	P					X	X	
Astragalus oocalycis	Poisonvetch	F	P				X	X	X	
Astragalus pattersoni	Patterson poisonvetch	F	P			X	X	X		X
Astragalus schmolliae	Loco	F	C	X		X				
Astragalus scopulorum	Loco	F	P			X	X	X		
Atriplex canescens	Four-winged saltbrush	S	D				X	X		

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Atriplex confertifolia	Shadscale	S	D					X		
Atriplex corrugata	Mat saltbrush	H	R					X		
Atriplex nuttallii	Nuttals saltbrush	H	R					X		
Atriplex rosea	Annual saltbrush	H	R				X	X		
Avena fatua	Wild Oat	F	C			X	X	X		
Bahia dissecta		F	P							
Balsamorrhiza sagittata	Balsam root	F	C	X						
Berberis fendleri	Colorado barberry	S	P	X	X					
Betula fontinalis	Rocky mountain brich	T	C	X	X	X	X			X
Blepharoneuron tricholepis	Pine dropseed	G	A	X						
Bouteloua curtipendula	Sideoats grama	G	C			X	X	X	X	
Bouteloua gracilis	Blue grama	G	A			X	X	X	X	
Brickellia brachyphylla	Brickellbrush	HS	R	X	X					
Brickellia californica	Brickellbrush	HS	R	X		X	X			
Brickellia grandiflora	Brickellbrush	F	R	X		X	X			
Brickellia oblongifolia	Brickelbrush	F	R	X		X	X	X		
Brickellia scabra	Brickellbrush	HS	R			X	X	X		
Bromus anomalus	Nodding brome	G	A			X	X	X	X	
Bromus carinatus	California brome	G	R			X	X	X	X	

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Bromus Ciliatus	Fringed brome	G	P	X		X	X	X	X	
Bromus inermis	Smooth brome	G	A	X		X	X	X		
Bromus Japonicus	Japanese chess	G	R					X	X	
Bromus marginatus	Mountain brome	G	A	X		X	X			
Bromus tectorum	Cheatgrass	G	D	X	X	X	X	X	X	X
Calochortus gunnisonii	Mariposa lily	F	P	X		X	X			
Calochortus nutallii	Segolily mariposa	F	P				X	X	X	
Camelina microcarpa	False flax	F	P			X	X	X	X	
Campanula rotundifolia	Harebell	F	R	X	X					
Capsella bursapastoris	Shepard's purse	F	C	X	X	X	X	X	X	X
Cardamine cordifolia	Bittercress	F	C	X	X	X				X
Cardaria draba	Whitetop	F	P			X	X	X	X	
Carex geyeri	Geyer's sedge	GL	A	X		X				
Carex festivella	Mountain meadow sedge	GL	P	X	X	X	X			
Carex heliophila	Elk sedge	GL	R				X	X		
Carex occidentalis	Elk sedge	GL	P	X		X	X	X		
Carex praegracilis	Clustered field sedge	GL	P					X	X	X
Castilleja chromosa	Red Indian paintbrush	F	C	X		X	X			
Castilleja linariaefolia	Orange Indian paintbrush	F	A	X		X	X	X		
Ceanothus fendleri	New Jersey tea	S	C	X						
Centaurea picris	Russian knapweed	F	R			X	X	X		
Cerastium arvense	Mouse-ear chickweed	F	C	X		X	X	X		
Cercocarpus intricatus	Mountain mahogany	S	R			X	X			

ABLE 2 (Continuud)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation	
Cercocarpus montanus	True mountain mahogany	S	D			X	X				
Chaenactis douglasii	False yarrow	F	P	X		X	X	X			
Cheilanthes feei	Lip fern	P	P	X	X						
Chenopodium album	Lambsquarters	F	A	X		X	X				
Chenopodium berlandieri	Goosefoot	F	C	X		X	X	X	X		
Chenopodium capitatum	Goosefoot	F	P	X	X	X	X				
Chenopodium fremontii	Goosefoot	F	A	X		X	X				
Chenopodium glaucum	Goosefoot	F	P			X	X	X	X		
Chenopodium leptophyllum	Goosefoot	F	R	X	X	X	X	X			
Chenopodium pratericola	Goosefoot	F	C	X		X	X				
Chorispora tenellae	Chorispora	F	P		X	X	X				
Chrysopsis villosa	Hairy golden aster	F	A	X		X	X	X			
Chrysothamnus depressus	Dwarf rabbitbrush	H	R			X	X	X			
Chrysothamnus nauseousus		Rubber rabbitbrush			S	A	X		X	X	X
Chrysothamnus viscidiflorus	Rabbitbrush	S	A	X		X	X	X			
Cichorium intybus	Chicory	F	P			X	X	X		X	
Cirsium arvense	Canadian thistle	F	C	X		X	X	X	X		
Cirsium lanceolatum	Bull thistle	F	C	X		X	X	X	X		
Cirsium neomexicanum	Thistle	F	P			X	X	X	X		
Cirsium pulchellum	Thistle	F	P	X		X	X	X	X		

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Cirsium undulatum	Wavy-leaved thistle	F	P	X		X	X	X	X	
Claytonia lanceolata	Spring beauty	F	P	X		X	X		X	
Clematis hirsutissima	Leather flower	F	P	X		X	X			
Clematis ligusticifolia	Virgin's bower	V	A	X		X				X
Clematis pseudoalpina	Virgin's bower	V	P	X		X				
Cleome lutea	Yellow beeplant	F	C					X	X	
Cleome serrulata	Rocky Mountain beeplant	F	P	X		X	X	X	X	
Collinsia parviflora	Blue-eyed Mary	F	A	X	X	X	X			
Collomia grandiflora		F	R			X	X			
Collomia linearis		F	P	X		X	X			
Comandra umbellata	Bastard toadflax	F	P	X		X				
Conium maculatum	Poison hemlock	F	P	X		X	X			X
Convolvulus arvensis	Bindweed	F	A	X		X	X	X		
Conyza canadensis	Horseweed	F	R				X	X	X	
Corallorhiza maculata	Coral root	F	P	X						
Cordylanthus kingii	Birdbeak	F	R			X	X			
Cordylanthus ramosus	Birdbeak	F	P	X		X	X	X		
Cordylanthus wrightii	Birdbeak	F	P	X		X	X	X		
Cornus stolonifera	Redosier dogwood	S	P	X	X	X	X			X
Corydalis aurea	Golden smoke	F	C	X		X	X			
Cowania stansburiana	Cliffrose	S	P			X	X	X		
Crataegus erythropoda	Hawthorn	ST	C	X	X	X	X			X
Crepis acuminata	Hawksbeard	F	P	X		X	X			

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Cryptantha bakeri		F	P	X			X			
Cryptantha fendleri		F	P	X		X	X			
Cryptantha flava		F	C	X		X	X	X		
Cryptantha gracilis		F	P				X	X		
Cynoglossum officinalis	Houndstongue	F	P	X		X	X			
Dactylis glomerata	Orchard grass	G	P	X	X	X	X	X	X	X
Danthonia intermedia	Timber oatgrass	G	R	X	X	X				X
Datura meteloides	Thornapple	F	R				X	X		
Delphinium nelsoni	Little larkspur	F	O	X		X	X	X		
Descruainia pinnata	Tansy mustard	F	P	X		X	X	X		
Descurainia sophia	Tansy mustard	F	A	X		X	X	X		
Distichlis stricta	Inland saltgrass	G	P					X	X	X
Draba reptans	Whitlow-grass	F	P			X	X	X	X	
Draba nolobe	Whitlow-grass	F	R	X	X					
Echinocactus mesaeverdae	Barrel cactus	S	R				X	X		
Echinocactus simpsonii	Barrel cactus	S	P			X	X			
Echinocactus whipplei	Barrell cactus	S	P				X	X		
Echinocereus coccineus	Red hedgehog cactus	S	P	X		X				
Echinocereus fendleri	Hedgehog cactus	S	R					X	X	
Echinochloa crusgalli	Barnyard grass	G	C						X	X
Elaeagnus angustifolia	Russian olive	S	P			X	X	X	X	X
Eleocharis macrostachya	Spikesedge	GL	C	X	X	X	X	X	X	X
Ellisia nycetela		F	R	X	X	X	X	X	X	X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Elymus canadensis	Canada wildrye	G	P			X	X	X	X	X
Clymus salinus	Wild rye	G	R					X		
Ephedra torreyana	Jointfir	S	P			X	X	X		
Ephedra viridis	Brigham tea	S	P			X	X	X		
Epilobium hornemanni	Dwarf fireweed	F	R	X	X					X
Epilobium paniculatum	Autumn fireweed	F	R	X		X	X	X		
Equisetum arvense	Horsetail	F	P	X	X	X	X	X	X	X
Equisetum laevigatum	Horsetail	F	R	X	X	X	X	X	X	X
Erigeron divergens	Spreading fleabane	F	C				X	X		
Erigeron eatonii	Fleabane	F	P	X		X	X			
Erigeron engelmannii	Fleabane	F	C	X		X	X	X	X	
Erigeron speciosus	Fleabane	F	P	X		X	X	X		
Erigeron utahensis	Fleabane	F	P				X	X	X	
Eriogonum alatum	Winged eriogonum	F	C	X		X	X	X	X	
Eriogonum cernuum	Umbrella plant	F	C			X	X	X		
Eriogonum corymbosum		F	R				X	X		
Eriogonum flavum		F	C	X		X	X	X		
Eriogonum fusiforme	Desert trumpet	F	R					X	X	
Eriogonum inflatum	Desert trumpet	F	R					X		
Eriogonum jamesii		F	C	X		X	X	X		
Eriogonum lonchophyllum		F	R				X	X		
Eriogonum microthecum	Slenderbush eriogonum	F	P				X	X		
Eriogonum racemosum	Red-root eriogonum	F	P			X	X			

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Eriogonum umbellatum	Sulfur flower	F	C	X		X	X	X		
Erodium cicutarium	Storksbill, filaree	F	A	X		X	X	X	X	
Erysimum asperum	Western wallflower	F	P	X	X					
Erysimum inconspicuum	Wallflower	F	R			X	X			
Eupatorium herbaceum		F	R			X	X			
Euphorbia fendleri	Spurge	F	C			X	X	X	X	
Euphorbia robusta	Spurge	F	P			X	X			
Eurotia lanata	Winterfat	H	R				X	X		
Fendlera rupicola	Cliff fendlerbush	S	P			X	X			
Festuca arizonica	Arizona fescue	G	R	X		X				
Festuca idahoensis	Idaho fescue	G	R	X		X				
Festuca octoflora	Six-weeks fescue	G	P			X	X	X	X	
Festuca thurberi	Thurber's fescue	G	C	X		X	X			
Forestiera neomexicana	Coyote bush	S	P							X
Fragaria americana	Strawberry	F	P			X	X			
Fragaria ovalis	Strawberry	F	C	X		X	X			
Fraxinus anomala	Singleleaf ash	S	R				X		X	
Fritillaria atropurpurea	Fritillary	F	R	X	X	X				
Gaillardia aristata	Blanketflower	F	P				X	X	X	
Galium aparine	Bedstraw	F	P	X		X				
Galium coloradoense	Colorado bedstraw	F	P	X		X				
Gaura coccinea	Butterfly weed	F	C	X		X	X			
Gaura neomexicana	Tall butterfly weed	F	P			X	X	X		

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Gayophytum ramosissimum	Groundsmoke	F	R			X	X	X		
Geranium caespitosum	Wild geranium	F	P	X		X	X			
Geranium fremontii	Wild geranium	F	R			X	X	X	X	
Geranium nervosum	Wild geranium	F	R	X		X	X			
Geranium richardsonii	Wild geranium	F	P	X	X	X	X	X		
Gilia aggregata	Scarlet trumpet flower	F	C	X		X	X			
Gilia congesta	Densely-flowered gilia	F	P	X		X	X	X		
Gilia haydenii		F	P			X	X	X		
Gilia leptomeria	Naked-stemmed gilia	F	P			X	X	X		
Gilia montezumae		F	R	X		X				
Gilia sinuata	Obscure gilia	F	P	X		X	X	X		
Gilia texana	Texas gilia	F	C	X		X	X	X		
Glecoma hederacea	Ground ivy	F	P	X		X	X			X
Grayia spinosa	Hop-sage	S	R					X		
Grindelia arizonica	Gumweed	F	P	X		X	X			
Grindelia squarosa	Gumweed	F	P	X		X	X	X		
Gutierrezia sarothrae	Broom snakeweed	H	P			X	X	X		
Habenaroa hyperborea	Bog orchid	F	P	X	X	X				X
Hackelia floribunda	Sticktight	F	P	X		X	X			
Hackelia gracilenta	False forget-me-not	F	P	X		X	X			
Hackelia leptophylla	Hackelia	F	A	X		X	X			
Halogeton glomeratus	Halogeton	H	P			X	X	X		

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Haplopappus armerioides	Goldenweed	F	P				X	X	X	
Haplopappus gracilis	Goldenweed	F	P	X		X	X	X		
Haplopappus nuttallii	Goldenweed	F	P			X	X	X		
Hedeoma drummondii	Mock-pennyroyal	F	P			X	X	X	X	
Hedysarum boreale	Sweet vetch	F	P	X						
Helianthella uniflora	Little sunflower	F	P	X		X	X			
Helianthus annus	Common sunflower	F	P	X		X	X	X		
Helianthus nuttallii	Little sunflower	F	P	X		X	X	X		
Helianthus petiolaris		F	P	X						
Heracleum lanatum	Cowparsnip	F	R	X	X					
Hieracium fendleri	Hawkweed	F	P	X	X	X	X			
Heuchera parvifolia	Alumroot	F	P	X	X	X	X			
Hilaria jamesii	Galleta	G	A			X	X	X	X	
Hippuris vulgaris	Marestail	F	R	X	X	X	X	X	X	X
Holodiscus dumosus	Rock spirea	S	R	X	X					
Hordeum jubatum	Foxtail barley	G	A	X		X	X	X	X	
Hordeum pusillium	Little barley	G	R	X		X	X	X	X	
Hordeum vulgare	Barley	G	R	X		X	X	X	X	
Hydrophyllum Fenderi	Water leaf	F	P	X	X	X				
Hymenopappus filifolius		F	P			X	X	X		
Hymenoxys vacaulis	Pinque	H	P	X		X	X			
Hymenoxys richardsonii	Pinque	H	P	X		X	X	X		
Iliamna rivularis	Wild hollyhock	F	R	X	X	X				X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riperian Vegetation
Irs missouriensis	Rocky Mountain iris	F	C	X		X	X			X
Iva axillaris	Poverty weed	F	C					X	X	X
Iva xanthifolia	Poverty weed	F	P					X	X	X
Juncus balticus	Wirerush	GL	P	X	X	X	X	X	X	X
Juncus longistylis	Long-styled rush	GL	A	X	X	X	X	X	X	X
Juncus saximontanus		GL	A	X	X	X	X	X	X	X
Juniperus monosperma	Oneseed juniper	ST	P			X				
Juniperus scopulorum	Rocky Mountain juniper	T	D	X		X	X			
Juniperus osteosperma	Utah juniper	ST	D			X	X	X		
Koeleria cristata	Prairie junegrass	G	C	X		X	X	X	X	
Lactuca pulchella	Wild lettuce	F	C	X	X	X	X	X	X	X
Lactuca scariola	Wild lettuce	F	R	X		X	X			
Lappula redowskii	Stickseed	F	A	X		X	X	X		
Lathyrus leucanthus	Peavine	F	P	X						
Lathyrus pauciflorus	Fewflower peavine	F	R	X						
Lepidium campestre	Pepperweed	F	R	X		X	X	X	X	
Lepidium densiflorum	Pepperweed	F	P	X		X	X	X	X	
Lepidium montanum	Pepperweed	F	A	X		X	X			
Lepidium perfoliatum	Clasping pepperweed	F	P	X		X	X			
Leptodactylon pungens	Granite gilia	F	C	X		X	X			
Lesquerella intermedia	Bladder pod	F	P			X	X	X		
Lesquerella rectipes	Bladder pod	F	P	X		X	X			
Leucocrinum montanum	Sand lily	F	P	X		X	X	X	X	

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Ligusticum porteri	Lovage	F	C	X	X					
Linaria vulgaris	Toadflax	F	C	X		X	X			
Linum lewisii	Wild flax	F	C	X		X	X	X		
Linum rigidum	Flax	F	R	X		X	X			
Lithospermum ruderale	Puccoon	F	R	X		X	X	X		
Lomatium grayi	Biscuitroot	F	P			X	X	X		
Lonicera involucrata	Twinberry	S	P		X					X
Lotus wrightii	Deervetch	F	A	X						
Lupinus ammophilus	Sand lupine	F	C	X		X	X	X		
Lupinus caespitosus	Stemless lupine	F	P				X	X		
Lupinus caudatus	Lupine	F	C	X		X	X			
Lupinus kingi	King's lupine	F	P	X						
Lychnis drummondii	Campion	F	P	X		X	X	X		
Lycium pallidum	Pale wolfberry	S	R				X			
Lycurus phleoides	Wolftail	G	R			X	X	X	X	
Lygodesmia grandiflora	Skelton plant	F	R			X	X	X		
Madia glomerata		F	P		X	X	X			
Mahonia repens	Oregon grape	H	C	X		X	X			
Malva neglecta	Weedy mallow	F	P			X	X			
Mamillaria vivipara	Ball cactus	S	P			X	X	X		
Marrubium vulgare	Hoarhound	F	P	X		X	X			
Medicago lupulina	Black medic	F	A	X						
Medicago sativa	Alfalfa	F	P	X	X	X	X	X	X	X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Melilotus alba	White sweetclover	F	C			X	X			X
Melilotus officinalis	Yellow sweetclover	F	C	X		X	X			X
Mentha arvensis	Mint	F	P	X	X	X	X	X	X	X
Mentzelia albicaulis	Stick leaf	F	R	X		X	X			
Mentzelia multiflora	Stick leaf	F	R			X	X	X		
Metzelia nuda	Stick leaf	F	R	X		X	X			
Mertensia fusiformis	Bluebells	F	P	X	X	X				
Microsteris humilis	Low microsteris	F	P	X		X	X	X		
Mirabilis multiflora	Wild four-o'clock	F	P	X		X	X	X		
Mirabilis oxybaphoides	Wild four-o'clodk	F	R			X	X	X		
Moldavica parviflora	Dragonhead	F	R	X	X	X	X			
Monarda fistulosa	Horsemint	F	P	X	X	X				
Muhlenbergia andina	Foxtail muhly	G	R	X		X	X			X
Muhlenbergia asperifolia	Scratch grass	G	P			X	X	X	X	X
Muhlenbergia montana	Mountain muhly	G	A	X		X	X			
Muhlenbergia richardsonis	Mat muhly	G	P			X	X	X		X
Muhlenbergia wrightii	Spike muhly	G	P				X	X		X
Myosurus minimus	Mousetail	F	P	X	X	X	X	X	X	X
Myriophyllum exalbescens	Watermilfoil	F	R	X		X	X			
Navarretia breweri	Yellow-flowered navarretia	F	R			X	X			
Nepeta cataria	Catnip	F	R			X	X			

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Nicotiana attenuata	Wild tobacco	F	R			X	X	X		
Oenothera albicaulis	Evening primrose	F	C	X		X	X			
Oenothera caespitosa	Evening primrose	F	C	X		X	X			
Oenothera coronopifolia	Evening primrose	F	P		X	X	X			
Oenothera flava	Evening primrose	F	R	X		X	X	X		
Oenothera hookeri	Yellow evening primrose	F	C			X	X			
Oenothera pallida	Evening primrose	F	P	X		X	X			
Opuntia davisii	Cholla	S	R					X	X	
Opuntia fragilis	Brittle prickly pear	S	O				X	X	X	
Opuntia hystricina	Prickly pear	S	R			X	X			
Opuntia phaeacantha	Prickly pear	S	P			X	X			
Opuntia polycantha	Prickly pear	S	P			X	X			
Orobanche fasciculata	Broomrape	F	P	X		X	X	X		
Orthocarpus luteus	Owlclover	F	C	X		X	X	X		
Orthocarpus purpureo albus	Owlclover	F	C	X		X	X	X		
Oryzopsis hymenoides	Indian ricegrass	G	A	X	X	X	X	X	X	
Oryzopsis micrantha	Little seed ricegrass	G	R	X		X	X	X		
Osmorhiza chilensis	Western sweet cicely	F	P	X	X	X				X
Osmorhiza obtusa	Sweet cicely	F	P	X	X	X				X
Osmorhiza occidentalis	Mountain sweet cicely	F	P	X	X	X				X
Oxytenia acerosa	Copper weed	F	P				X	X	X	

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Oxytropis deflexa	Crazyweed	F	C	X		X	X			
Osytropis lambertii	Crazyweed	F	C			X	X	X	X	
Pachystima myrsinites	Myrtle boxleaf	H	A	X	X					
Panicum capillare	Witchgrass	G	R			X	X	X	X	
Parthenocissus vitacea	Virginia creeper	V	R			X	X			
Pedicularis contranthera	Lousewort	F	R			X	X			X
Penstemon angustifolius	Penstemon	F	R			X	X	X		
Penstemon barbatus	Beardlip penstemon	F	P	X	X	X				
Penstemon bridgesii	Penstemon	F	R			X	X			
Penstemon comarrhenus	Penstemon	F	P			X	X	X		
Penstemon eatonii	Penstemon	F	P			X	X			
Penstemon linariodes	Narrowleaf beard's tongue	F	A	X		X	X			
Penstemon laricifolius	Penstemon	F	P			X	X			
Penstomon strictus	Tall blue beard's tongue	F	A	X	X					
Peraphyllum ramosissimum	Squawapple	S	A			X	X			
Phacelia corrugata	Scorpion weed	F	A			X	X	X		
Phacelia demissa	Scorpion weed	F	R			X	X			
Phacelia heterophylla	Scorpion weed	F	P	X		X	X	X	X	
Phacelia neomexicana	Scorpion weed	F	P	X		X	X	X		
Phacelia splendens	Scorpion weed	F	R				X	X		

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Philadelphus microphyllus	Mockorange	S	R			X	X			
Phleum alpinum	Alpine timothy	G	R	X	X					X
Phleum pratense	Timothy	G	A	X	X	X				X
Phlox hoodii	Phlox	F	C			X	X	X		
Phlox longifolia	Longleaf phlox	F	P			X	X	X		
Phoradendron juniperinum	American mistletoe	F	C			X				
Phragmites communis	Common reedgrass	G	R							X
Physalis fendleri	Ground cherry	F	R			X	X	X		
Physalis lanceolata	Ground cherry	F	P			X	X	X	X	
Physaria australis	Common twinpod	F	C			X	X			
Physaria floribunda	Twinpod	F	C	X		X	X	X		
Picea pungens	Blue spruce	T	R		X					
Pinus edulis	Pinyon pine	T	D			X				
Pinus ponderosa	Ponderosa pine	T	D	X	X					
Plagiobothrys scopulorum X		Popcorn flower		F	C	X		X	X	X X
Plantago lanceolata	English plantain	F	C	X	X	X	X	X	X	X
Plantago major	Common plantain	F	C	X	X	X	X	X	X	X
Plantago purshii	Woolly indian wheat	F	C			X	X	X	X	
Poa annua	Annual bluegrass	G	C	X		X	X	X	X	X
Poa compressa	Canada bluegrass	G	P	X		X	X	X	X	
Poa fendleriana	Muttongrass	G	D	X		X	X	X	X	

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Poa longiligula		G	P	X		X	X	X	X	
Poa pratensis	Kentucky bluegrass	G	D	X	X	X	X	X	X	X
Poa secunda	Sandberg's luegrass	G	A	X		X	X	X	X	
Polemonium foliossissimum	Jacob's ladder	F	P	X	X					
Polygonum aviculare	Knotweed	F	C	X		X	X	X	X	X
Polygonum convolvulus	Knotweed	F	R			X	X	X	X	
Polygonum sawatchense	Knotweed	F	C	X		X	X	X	X	
Polypogon monspeliensis	Beardgrass	G	R			X	X	X	X	X
Populus angustifolia	Narrowleaf cottonwood	T	D	X		X	X	X		X
Populus fremontii	Fremont poplar	T	R			X	X	X	X	X
Populus tremuloides	Quaking aspen	T	R	X	X	X				
Populus wislizeni	Rio Grande poplar	T	R			X	X	X	X	X
Portulaca oleracea	Purslane	F	P	X		X	X	X	X	
Potentilla gracilis	Cinquefoil	F	P	X	X	X	X	X		
Potentilla pennsylvanica	Cinquefoil	F	R	X	X	X	X	X	X	
Potentilla pulcherrima	Cinquefoil	F	P	X	X					
Prunella vulgaris	Healall	F	P	X	X	X	X			
Prunus virginiana	Common chokecherry	S	C	X	X	X	X			X
Pseudotsuga menziesii	Douglas fir	T	C		X					
Pteridium aquilinum	Bracken fern	F	R	X	X					
Pterospora andromedea	Pinedrops	F	C	X	X					

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Puccinellia distans	Alkali grass	G	R			X	X	X	X	X
Pulsatilla ludoviciana	Pasque flower	F	C	X	X	X	X	X		
Purshia tridentata	Antelope bitterbush	S	A		X	X				
Quercus gambelii	Gambel oak	S	D	X		X	X			
Quercus turbinella	Oak	S	R		X	X				
Ranunculus cymbalana	Shore buttercup	F	C	X	X	X	X	X	X	X
Ranunculus testiculatus	Buttercup	F	P					X	X	
Raphanus raphanistrum	Wild radish	F	R			X	X	X	X	X
Ratibida columnifera	Prairie coneflower	F	R			X	X	X	X	X
Rhamnus smithii	Smith's buckthorn	S	R			X	X			
Ribes aureum	Golden currant	S	P	X		X	X			
Ribes cereum	Early currant	S	C	X		X	X			
Ribes lepthanthum	Gooseberry	S	P	X	X					
Rhus radicans	Western poison ivy	S	R	X		X				X
Rhus trilobata	Skunkbush sumac	S	A	X		X	X			
Robinia neomexicana	New Mexican locust	T	R			X	X	X		X
Rorippa nasturtium-aquaticum	Watercress	F	C	X	X	X	X	X	X	X
Rorippa obtusa	Watercress	F	P							X X
Rosa acicularis	Wild rose	S	C	X	X	X	X			X
Rosa nutkana	Wild rose	S	P	X	X	X	X	X		
Rosa woodsii	Wild rose	S	C	X	X	X				
Rudbeckia laciniata	Coneflower	F	R	X		X	X			X
Rumex acetosella	Dock	F	C	X		X	X			X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Rumex crispus	Curly dock	F	P	X		X	X			X
Rumex hymenosepalus	Canaigre	F	R				X	X	X	
Salix amygdaloides	Peachleaf willow	S	A			X	X	X	X	X
Salix exigua	Sandbar willow	S	A					X	X	X
Salix lasiandra	Red willow	S	R				X	X	X	X
Salix lutea	Yellow willow	S	R			X	X			X
Salsola kali	Russian thistle	F	A	X		X	X	X	X	
Salvia reflexa	Lanceleaf sage	F	R			X	X	X	X	
Sambucus coerulea	Blue elderberry	S	R	X	X	X				
Sanicula marilandica	Snake root	F	P			X	X	X		
Saponaria vaccaria	Soapwort	F	A			X	X	X	X	
Sarcobatus vermiculatus	Black greasewood	S	D					X	X	X
Scirpus acutus	Hardstem bullrush	GL	R			X	X	X	X	X
Scirpus americanus	Three-square bullrush	GL	C	X		X	X	X	X	X
Scirpus paludosus	Marsh bullrush	GL	C	X		X	X	X	X	X
Scirpus validus	American great bullrush	GL	P			X	X	X	X	X
Scutellaria galericulata X		Skullcap		F	R			X	X	X
Sedum stenopetalum	Stonecrop	F	C	X	X	X	X	X	X	
Senecio longilobus	Groundsel	F	P			X	X	X	X	
Senecio multilobatus	Groundsel	F	P			X	X	X	X	
Senecio mutabilis	Groundsel	F	P	X		X	X	X	X	
Shepherdia argentea	Silver buffaloberry	S	P			X	X	X	X	X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Sidalcea candida	False mallow	F	P	X	X	X	X	X	X	X
Sidalcea neomexicana	False mallow	F	P	X		X	X	X	X	X
Silene antirrhina	Campion	F	P			X	X	X		
Silene menziesii	Catchfly	F	C	X	X	X	X	X		
Silene noctiflora	Campion	F	R	X	X	X	X	X		
Sisymbrium altissimum	Tumble mustard	F	A	X		X	X	X		
Sisymbrium linifolium	Tumble mustard	F	P	X		X	X	X	X	
Sisyrinchium halophilum	Blue-eyed grass	F	R	X		X				X
Sisyrinchium montanum	Blue-eyed grass	F	P	X		X	X	X	X	X
Sitanion hystrix	Bottlebrush squirreltail	G	A	X	X	X	X	X	X	
Smilacina racemosa	False Soloman's seal	F	R	X	X					
Smilacina stellata	False Soloman's seal	F	C	X	X	X				
Solanum jamesii	Wild potatoe	F	R	X			X			
Solanum triflorum	Nightshade	F	P	X		X	X	X	X	
Solidago canadensis	Goldenrod	F	P	X		X	X	X		
Solidago missouriensis	Goldenrod	F	C	X	X	X	X	X	X	
Solidago petradoria	Rock goldenrod	F	P	X		X	X	X	X	
Solidago sparsiflora	Goldenrod	F	R	X		X	X	X		
Sonchus asper	Sow thistle	F	C			X	X	X	X	
Sphaeralcea coccinea	Scarlet globemallow	F	C	X		X	X	X	X	
Sphaeralcea parvifolia	Mallow	F	C			X	X	X	X	

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation	
Sporobolus airoides	Alkali sacaton	G	P			X	X	X	X		
Sporobolus cryptandrus	Sand dropseed	G	P	X		X	X	X	X		
Stachys plaustris	Betony	F	P	X		X	X			X	
Stanleya pinnata	Desert princeplume	F	P			X	X	X	X		
Stanleyella wrightii		F	R			X	X	X	X		
Stellaria jamesiana	Chickweed	F	C	X	X	X	X			X	
Stellaria media	Chickweed	F	C	X	X	X	X				
Stephanomeria tenuifolia		Wire lettuce		F	C	X	X	X	X	X	X
Stipa columbiana	Subalpine needle-grass	G	R	X	X	X					
Stipa comata	Needle and thread	G	A	X		X	X	X	X		
Stipa lettermani	Letterman needle-grass	G	P	X	X	X					
Stipa neomexicana	New Mexico feathergrass	G	R			X	X	X	X		
Stipa robusta	Sleepy grass	G	P	X		X	X	X			
Stipa speciosa	Desert needlegrass	G	R	X		X	X	X			
Stipa viridula	Green needlegrass	G	R	X		X	X	X	X		
Streptanthus cordatus	Twistflower	F	R			X	X	X	X		
Swertia albomarginata	Green gentian	F	R			X	X				
Symphoricarpos oreophilus	Mountain snowberry	S	P	X	X						
Tamarix pentandra	Salt cedar	ST	D					X	X	X	
Taraxacum officinale	Common dandelion	F	C	X	X	X	X	X	X	X	
Tetradymia canescens	Gray horsebrush	S	P	X		X	X	X			

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Tetradymia spinosa	Cottonthorn horse-brush	S	P			X	X	X		
Teucrinum canadense	Germander	F	R	X		X	X	X	X	X
Thalictoum dasycarpum	Talle meadow rue	F	R			X	X			X
Thalictrum fendleri	Meadow rue	F	P	X	X	X				
Thelypodium rhomboideum	Thelypodium	F	R	X		X				
Thermopsis divaricarpa	Golden pea	F	C	X	X	X				
Thermopsis montana	Mountain golden pea	F	R	X	X					
Thlaspi alpestre	Penny cress	F	C	X	X	X				
Townsendia incana	Easter daisy	F	C			X	X	X	X	
Townsendia sericea	Easter daisy	F	C	X		X	X	X	X	
Tragopogon pratensis	Goatsbeard	F	P	X		X	X			X
Trifolium pratense	Red clover	F	P	X	X	X	X	X		X
Trifolium repens	White Dutch clover	F	P	X	X	X	X	X		X
Triglochin maritima	Arrograss	GL	R	X	X	X	X	X	X	X
Typha angustifolia	Cattail	GL	P					X	X	X
Typha latifolia	Common cattail	GL	A	X	X	X	X	X	X	X
Urtica dioica	Stinging nettle	F	P	X	X					
Verbascum thapsus	Mullein	F	C	X		X	X	X	X	
Verbena bracteata	Big bract verbena	F	R	X		X	X			
Verbena wrightii	Vervain	F	R			C	C			
Veronica americana	Speedwell	F	P	X	X	X	X			X
Vernoica anagallis-aquatica	Speedwell	F	P			X	X	X	X	X

TABLE 2 (Continued)

Scientific Name	Common Name	Life Form	Relative Abundance	Ponderosa Pine	Mixed Conifer	Pinyon Juniper	Mountain Brush	Sage and Other Low Brush	Grass	Bottomland Riparian Vegetation
Veronica serpyllifolia	Speedwell	F	P	X	X	X	X			
Vicia americana	American vetch	F	P	X	X	X				
Viguiera multiflora	Goldeneye	F	P	X	X	X	X	X	X	X
Viola adunca	Western long-spurred violet	F	C	X	X	X	X			
Viola canadensis	White violet	F	C	X	X	X	X			
Woodsia oregana	Wood fern	P	P	X	X	X				
Wyethia amplexicaulis	Mulesears	F	R	X	X					
Wyethia arizonica	Arizona mules-ears	F	P	X		X	X			
Xanthium italicum	Cocklebur	F	P			X	X	X	X	
Yucca angustissima	Narrowleaf yucca	H	C	X		X	X	X		
Yucca baccata	Broad-leafed yucca	H	C	X		X	X			
Yucca harrimaniae	Harriman yucca	H	R			X	X	X		
Zygadenus gramineus	Grassy deathcamas	F	P	X		X				
Zygadenus paniculatus	Death camas	F	R	X		X	X	X		

T - Tree

S- Shrub

F - Forb (herbaceous flowering plant other than a grass)

G - Grass

H - Half shrub--a "soft_ half-woody, shrub

Relative Abundance Symbol Definitions:

R - Rare - The species is present, on the average, in 1 of 20 plots in its community. Herb plots measure 1 square meter; shrub plots measure 20 square meters and tree plots measure 200 square meters.

P - Present - The species is found in approximately 1 of 4 plots in the proper community.

C - Common - The species is found in approximately 1 of 2 plots in the proper community.

A - Abundant - The species is present in approximately 2 or more of 3 plots in its community.

occupies the better, moister soils and also occurs in park areas, primarily a consequence of overgrazing. It also is a common component on flatter areas such as mesa tops with pinyon-juniper. The dominant plant is the Big Sage which occurs in clumps, interspersed with grass. The amount of grasses is inversely related to the amount of overgrazing. Under less grazed conditions perennial grasses will be more abundant. Sagebrush and pinyon-juniper create important winter range for big game.

Riparian woodlands are confined to the alluvial flood plain of rivers and waterways. Typical vegetation includes cottonwood, willow, cattails, rushes and sedges.

While not a natural stand type, cropland does constitute an integral part of the Study Area ecosystem dynamics. There are primarily two types of cropland, irrigated and dryland. Irrigated croplands are typically found adjacent to riparian areas and normally consist of alfalfa and native hay. Nonirrigated drylands are scattered on mesa tops in association with sagebrush and pinyon-juniper. These areas produce grain crops and pinto beans and attract mule deer, particularly during early spring and late fall green-up periods.

The various community types undergo successional changes as they evolve towards climax status. Several factors can play critical roles in this evolution. Four predominate man-related disturbances, overgrazing, fire, logging, and urban expansion, can induce very different community types leading to development of strikingly different landscape appearances.

Overgrazing occurs rather extensively in the Study Area. In the ponderosa pine forest it produces an increase in oakbrush, pine dropseed, needle and threadgrass and blue grass, and a decrease in mutton grass. Overgrazing has little effect on the ponderosa pine itself. In the pinyon-juniper and mountain shrub zones there is a significant reduction in the perennial grasses and herbaceous substory. Cheatgrass increases, but as other species disappear there is an increase in bare ground. Yucca increase, particularly in large areas of bare ground. However, the dominant species experience little noticeable effect. A similar result occurs in sagebrush communities; bare ground and annual herbs increase and perennial species decrease.

Fire has been identified as a constant and integral component of ecosystems in southwest Colorado, (Reference 7). Fire contributes to ecosystem health by maintaining a vigorous vegetational pattern. However, when fire occurs more frequently than normal, due to human influence, it can become deterimental to community health. Fire in the ponderosa pine ecotone (transitional zone) often leads to a decrease in pine to the advantage of Gambel's oak. Successive fires will increase the oakbrush community and decrease the ponderosa pine area markedly. In the pinyon-juniper community, fire tends to favor brush. In the other plant communities, a light fire causes major changes in the understory vegetation, and a hot fire eliminates the community. Annual plants (cheatgrass, squirrel tail grass, tumble mustard, alyssum, etc.) are greatly favored. From a rangeland point of view this results in a lowering of the range quality and carrying capacity.

Logging and fire often abet one another. Following logging, there usually is either an uncontrolled slash fire or a controlled burn. Logging not followed by fire can also result in the development of oakbrush community. By removing the overstory, the oak no longer has to compete for light and becomes quite vigorous.

Burning and restricted logging have definite beneficial implications for wildlife species while overgrazing and urban encroachment are detrimental. Urban-suburban development causes the greatest long term modification of the natural environment. The process of growth, development, and outward expansion typically results in a total elimination of native species.

WILDLIFE

Wildlife investigations conducted by the Colorado Division of Wildlife and the Fort Lewis College Biology Department have identified 50 species of mammals and 64 species of birds in the Durango area. Forty-eight of these are considered game species by the Colorado Division of Wildlife. In addition, twenty-two species of reptiles and seven species of amphibians have been found in the area. Wildlife species in the area are listed in Table 3. Game species are indicated by an asterisk.

The game species inventoried in the county by the Division of Wildlife include mule deer, elk, bighorn sheep, Rocky Mountain goat, black bear, mountain lion, turkey, blue grouse, ptarmigan, chukar, beaver, muskrat, mink, marten, bobcat, coyote, red fox, and grey fox.

The mule deer is probably the most abundant, most widely distributed and most economically important big game species within the area. West of Durango, in the Lightner Creek and Junction Creek drainages, critical winter range and fawning areas have been identified. The entire Durango area serves as winter range, while important salt lick areas occur in the vicinity of Hermosa. These significant deer habitat areas are identified in Figure 4.13 in the EIS.

The elk is secondary to the mule deer in abundance, distribution, and economic importance. The major herds in the area are located north of highway 160. A few of these animals migrate south, as evidenced by the road kills. The largest elk herd (1,700 to 2,000 animals) summers in the San Juan Mountains north of the Study Area and migrates along

TABLE 3

WILDLIFE SPECIES OF THE STUDY AREA

AMPHIBIANS

Tiger Salamander	common
Western Spadefoot Toad	occasional
Woodhouse's Toad	common
Red-spotted Toad	uncommon
Chorus Frog	common
Leopard Frog	common
Bullfrog	uncommon

REPTILES

Painted Turtle	common
Lesser Earless Lizard	uncommon
Leopard Lizard	uncommon
Collared Lizard	occasional
Desert Spiny Lizard	occasional
Eastern Fence Lizard	common
Sagebrush Lizard	common
Tree Lizard	occasional
Side-blotched Lizard	uncommon
Short-horned Lizard	common
Many-lined Skink	uncommon
Western Whiptail	uncommon
Little Striped Shiptail	uncommon
Palteau Whiptail	common
Striped Whipsnake	uncommon
Gopher Snake	common
Glossy Snake	uncommon
Milk Snake	uncommon
Black-necked Garter Snake	uncommon
Western Terrestrial Garter Snake	common
Night Snake	uncommon
Western Rattlesnake	uncommon

BIRDS

Great Blue Heron	occasional
*Snow Goose	occasional
*Mallard	common
*Gadwall	occasional
*Pintail	uncommon
*Green-winged Teal	common
*Blue-winged Teal	occasional
*Cinnamon Teal	occasional
*American Wigeon	occasional
*Common Goldeneye	common
*Common Merganser	common
Turkey Vulture	common

Goshawk	uncommon
Sharp-shinned Hawk	common
Cooper's Hawk	uncommon
Red-tailed Hawk	common
Swainson's Hawk	uncommon
Rough-legged Hawk	uncommon
Golden Eagle	common
Bald Eagle	common
Marsh Hawk	uncommon
Osprey	uncommon
Prairie Falcon	uncommon
American Kestrel	common
Peregrine Falcon	
*Gambel's Qual	uncommon
*Ring-neck Pheasant	uncommon
*Chukar	uncommon
Killdeer	common
*Common Snipe	uncommon
*Band-tailed Pigeon	uncommon
*Mourning Dove	common
Great-horned Owl	occasional
Burrowing Owl	uncommon
Common Flicker	common
Lewis' Woodpecker	common
Violet-green Swallow	common
Barn Swallow	common
Scrub Jay	common
*Black-billed Magpie	common
Common Raven	common
*Common Crow	common
Pinyon Jay	common
Plain Titmouse	uncommon
American Robin	common
Townsend's Solitaire	common
Blue-gray Gnatcatcher	common
*Starling	common
Warblers	common
*House Sparrow	common
Western Meadowlark	common
Red-winged Blackbird	common
Brewer's Blackbird	common
Green-tailed Towhee	common
Rufous-sided Towhee	common
Vesper Sparrow	common
Lark Sparrow	common
Sage Sparrow	common
Chipping Sparrow	common
Brewer's Sparrow	common

White-crowned Sparrow	common
*Turkey	
*Blue Grouse	occasional
*Ptarmigan	uncommon

MAMMALS

Wandering Shrew	uncommon
Merriam's Shrew	uncommon
Townsend's Big-eared Bat	uncommon
*Nuttall's Cottontail	common
*Desert Cottontail	common
*Black-tailed Jackrabbit	common
Least Chipmunk	common
Colorado Chipmunk	common
*Yellow-bellied Marmot	occasional
White-tailed Antelope Squirrel	uncommon
Spotted Ground Squirrel	uncommon
Rock Squirrel	common
Golden-mantled Ground Squirrel	common
*Gunnison's Prairie Dog	common
*Albert's Squirrel	uncommon
Pocket Gophers	occasional
Apache Pocket Mouse	uncommon
Ord's Kangaroo Rat	uncommon
*Beaver	common
Western Harvest Mouse	common
Deer Mouse	common
Brush Mouse	common
Pinyon Mouse	common
Northern Grasshopper Mouse	uncommon
White-throated Woodrat	common
Mexican Woodrat	common
Montone Vole	occasional
Long-tailed Vole	occasional
Mexican Vole	uncommon
*Muskrat	common
House Mouse	uncommon
Western Jumping Mouse	occasional
*Porcupine	common
*Raccoon	common
*Long-tailed Weasel	common
*Badger	occasional
*Striped Skunk	common
*Mule Deer	common
*Pronghorn	uncommon
*Bighorn Sheep	occasional
*Mountain Goat	uncommon
*Black Bear	occasional
*Mountain Lion	occasional
*Mink	occasional
*Marten	uncommon
*Bobcat	occasional
*Coyote	common

Highway 160 in the winter. The entire Study Area is used by elk, with the most important habitat areas in the Lightner Creek, Junction Creek, Animas River, and Florida River drainages. The significant use areas are identified in Figure 4.14 in the EIS.

Bighorn sheep are found primarily to the north of the Study Area in the alpine and subalpine regions of the San Juan Mountains. In recent years, individuals have been observed as far south as the junction of the Animas River and Hermosa Creek. The most significant habitat of the bighorn sheep within the EIS/201 Study Area is located in the Junction Creek and Animas River drainage. This area, indicated in Figure 4.15 in the EIS, has an estimated population of thirteen animals. The lower areas of the tributary streams to the Animas River, north of Durango, are designated winter range.

The Rocky Mountain goat is found to the north of the project area in the high elevations of the San Juan Mountains. Their range probably does not enter the EIS/201 Study Area.

Black bear are distributed throughout the San Juan Basin. Population estimates north of Highway 160 are about one bear per five square miles. These animals tend to confine themselves to the more remote areas of the National Forest.

Mountain lion occurs throughout the region. The principal range of the mountain lion is north of Highway 160. The estimated population in La Plata County is between four and seven individuals. The mountain lion's winter range is the same as the deer winter range. The use of any area is probably sporadic, and only occasionally do individuals remain in an area for any appreciable length of time.

In general, the major big game habitat is located north of Highway 160. The area of highest concentration is the Animas River drainage north and west of Durango. This area is designated as having critical winter range, concentration areas, and fawning and calving areas.

Upland game which occur in the San Juan basin include wild turkey, blue grouse, ptarmigan, and chukar partridge. Wild turkey are common to abundant throughout the region, primarily in the Gambel's oak-Pondersoa pine vegetation. Because of their preference for this plant association, turkeys typically occur north of Highway 160. Population estimates for these areas range from seven in the Rockwood area (north of the Study Area boundary above Hermosa) to fifty in the Lightner Creek area. Blue grouse are found throughout the region in the Gambel's oak-ponderosa pine community. In the vicinity of the Study Area their range consists of the upper regions of the Animas River, Junction Creek, Lightner Creek, and Florida River drainages. The estimated population density is 10 birds per square mile. Ptarmigan and chukar partridge habitat do not occur in the proximity of this project. Ptarmigan occur above timberline north of the Study Area, and chukar occur southwest near Cortez, Colorado.

The furbearing species in the region are beaver, muskrat, mink, red fox, gray fox, and pine marten. The first three species are water-oriented in their habitat requirements. Total beaver population in the Animas River and its major tributaries in La Plata County is estimated to be 362, and the Florida River basin has an estimated population of 194 animals. Currently, no population estimates are available for muskrat or mink in the Study Area. Foxes occur in the rougher terrain adjacent to river bottoms and agricultural areas. The combined population density for both fox species is estimated to be one per four square miles. The pine marten prefers the spruce-fir community of the higher elevations.

The two major predator species are the coyote and bobcat. Both occur throughout the region. The coyote is the more abundant of the two species and its population seems to be steadily increasing. The estimated coyote density is approximately two per square mile. Bobcats are most abundant in lower canyon areas and broken terrain. Major concentrations of bobcat in La Plata County are east and southeast of the Study Area.

Four special interest raptors of the area are the golden eagle, the bald eagle, the osprey, and the peregrine falcon. The golden eagle is common throughout the area. La Plata County has an estimated population of thirty-three birds. This species nests along bluffs and ridges and six nesting sites were identified in the Durango area in 1974. These nest sites are shown in Figure 4.18 in the EIS.

The bald eagle is a common winter resident of the area. In 1974 a nesting site was identified near Electra lake, north of the Study Area. However, there are no recent confirmed reports of breeding success in the area. The preferred habitat of the bald eagle is along streams and at large lakes and reservoirs. The major habitat of the bald eagle in the area is shown in Figure 4.17 of the EIS. There is an estimated winter population of twenty-five bald eagles along the Animas and Florida Rivers.

The osprey is not often seen around Durango. The principal nesting sites are north of the Study Area near Electra Lake and Vallecito. In 1974 an estimated six ospreys occurred in that area. The osprey, like the bald eagle, prefers lakes and streams. The Animas River valley is peripheral habitat for this species.

The peregrine falcon is known to exist in the vicinity of the Study Area. In 1974 and 1975 a pair of birds was observed to have an active nest site west of Durango but the nesting was apparently unsuccessful. Other old nest sites are located south of Durango, near Carbon Junction and near Lightner Creek. An important peregrine falcon and osprey habitat in the study area is shown in Figure 4.16 of the EIS. Recently the Colorado Division of Wildlife transplanted six young peregrine falcons to two prairie falcon nests in the area as part of their captive breeding program.

AQUATIC LIFE

Fish

Aquatic life information is available from the Colorado Division of Wildlife, (Reference 10). Fish data have been collected from fourteen streams in the Study Area. The inventoried fish data for these streams are presented in Table 4. Macroinvertebrate data are available from four streams in the Study Area. The distribution of macroinvertebrates in these streams is identified in Table 5.

The Division of Wildlife collected fish by electrofishing from six stations on the Animas River from Baker's Bridge to the state line. In addition, twelve tributaries in the Study Area were sampled. The following fish were collected in the Animas drainage: rainbow trout, brown trout, brook trout, cutthroat trout, flannelmouth sucker bluehead mountain sucker, western white sucker, speckled dace, freshwater sculpin, and bullhead catfish. Several additional species of fish have been planted or are known to be present within the drainage but were not collected during the sampling program. These include kokonee salmon, northern pike, channel catfish, largemouth bass, yellow perch, bluegill, and green sunfish.

TABLE 4

FISH INVENTORY BASED ON ELECTRO-FISHING[10]

Stream	Segment	Species	Est. No. Per Mile
Animas River	Stateline to Durango	Rainbow Trout	45
		Brown Trout	82
		Cutthroat Trout	4
		Flannel Mouth Sucker	283
		Blue Head Sucker	2 112
		Dace	151
		Sculpin	1 131
Animas River	Durango to Baker's Bridge	Rainbow Trout	103
		Brown Trout	170
		Brook Trout	6
		Cutthroat Trout	6
		Flannel Mouth Sucker	18
		Bluehead Sucker	4 488
		Western White Sucker	18
		Dace	70
		Sculpin	2 464
Florida River	Confluence to Hwy 160	Brown Trout	894
		Rainbow Trout	40
		Bullhead Catfish	13
		Dace	3 643
		Sculpin	845
Florida River	Hwy 160 to Lemon Res.	Brown Trout	563
		Rainbow Trout	933
		Sculpin	9 293
Junction Creek	Confluence to Junction Creek Picnic Area	Rainbow Trout	249
		Brown Trout	20
		Bluehead Sucker	399
		Sculpin	508
Hermosa Creek	Confluence to East Hermosa Creek Confluence	Rainbow Trout	198
		Brook Trout	123
		Sculpin	6 864
Hermosa Creek	East Hermosa Creek Confluence to Headwater	Rainbow Trout	20
		Cutthroat Trout	81
		Sculpin	2 843
East Fork Hermosa Creek	Confluence to Headwater	Rainbow Trout	
		Brook Trout	
		Sculpin	

Stream	Segment	Species	Est. No. Per Mile
Lightner Creek	Confluence to End of of County Rd. 207	Rainbow Trout	186
		Brown Trout	5
		Brook Trout	25
		Cutthroat Trout	5
		Bluehead Sucker	176
		Dace	1 690
		Sculpin	5 738
Coon Creek	Above Animas River	Brook Trout	
Corral Creek	Above Hermosa Creek	Cutthroat Trout	
Grassy Creek	Above Hermosa Creek	Cutthroat Trout	
		Rainbow Trout	
Hotel Draw	Above Hermosa Creek	No Fish Taken	
Petty Creek	Aboe Hermosa Creek	Cutthroat	
Relay Creek	Above Hermosa Creek	Brook Trout	
		Rainbow Trout	
		Cutthroat	
Sig Creek	Above Hermosa Creek	Brook Trout	

TABLE 5

MACRO-INVERTEBRATES OF SELECTED STREAMS[10]

EPHEMEROPTERA (Mayflies)	Bondad	ANIMAS RIVER Woeselskin	Purple Cliffs	Holiday Inn	32nd St.	Baker's Brdg.	LIGHTNER CREEK Upper	Lower	JUNCTION CREEK Upper	Lower	FLORIDA RIVER Upper	Lower
Baetidae												
Ameletus spp.				x								
Baetis spp.	x	x	x	x	x	x	x	x	x	x	x	x
Ephemerella spp.	x	x	x	x	x	x	x		x		x	
Tricorythodes											x	x
Heptageniidae												
Cinygma spp.	x						x		x			
Heptagenia spp.											x	x
Iron spp.	x	x	x	x	x	x	x	x	x	x		
Rhithrogena spp.		x	x	x	x	x					x	
PLECOPTERA												
Chloroperlidae												
Alloperla spp.	x			x	x	x			x	x	x	
Hastaperla spp.			x									
Perlidae												
Claassenia spp.						x			x			
Perlodidae												
Arcynopteryx spp.	x					x			x			x
Isogenus spp.	x	x	x		x	x			x			x
Isoperla spp.	x	x	x	x	x	x						
Pteronarcidae												
Pteronarcella spp.	x	x	x	x	x	x		x				
Nemouridae												
Allocapnia spp.		x										
Brachyptera spp.						x						
Capnia spp.	x			x	x	x						
Nemoura spp.						x	x					
TRICOPTERA												
Brachycentridae												
Brachycentrus spp.	x	x	x	x	x	x		x	x	x	x	x
Hydropsychidae												
Arctopsyche spp.	x	x	x	x	x	x		x	x	x	x	x
Hydropsyche spp.	x	x	x	x	x	x		x	x	x	x	x
Hydroptilidae												

	ANIMAS RIVER						LIGHTNER CREEK		JUNCTION CREEK		FLORIDA RIVER	
	Bondad	Weaselskin	Purple Cliffs	Holiday Inn	32nd St.	Baker's Brdg.	Upper	Lower	Upper	Lower	Upper	Lower
TRICOPTERA (Continued)												
Leptoceridae												
Oecetis spp.					x						x	x
Leptocella spp.											x	x
Helicopsychidae												
Helicopsyche spp.											x	x
Limnephilidae												
Hesperophylax spp.					x							
Rhyacophilidae												
Agapetus spp.	x	x	x	x	x							
Rhyacophila spp.			x			x						
DIPTERA												
Blephariceridae												
Agathon spp.	x	x	x	x	x	x						
Blepharicerid	x	x	x									
Chironomidae	x	x	x	x	x		x	x	x	x	x	x
Heleidae	x	x		x	x							
Rhagionidae												
Atherix spp.	x	x	x	x	x	x						x
Simuliidae												
Simulium spp.	x	x	x				x	x	x	x	x	
Stratiomyidae												
Euparyphus spp.						x	x				x	
Tipulidae												
Dicranota spp.					x							x
Hexatoma spp.	x	x	x	x	x							
Holorusia spp.					x							
COLEOPTERA												
Chrysomelidae												
Donacia spp.	x			x								
Curculionidae												
Phytonomus spp.		x				x						
Dryopidae												
Helichus spp.	x			x								
Dytiscidae		x	x	x								
[illegible]												

	ANIMAS RIVER						LIGHTNER CREEK		JUNCTION CREEK		FLORIDA RIVER	
	Bondad	Weaselskin	Purple Cliffs	Holliday Inn	32nd St.	Baker's Brdg.	Upper	Lower	Upper	Lower	Upper	Lower
Matus spp.						x				x	x	x
COLEOPTERA												
Narpus spp.			x		x							
Optioservus spp.	x	x	x		x					x	x	x
LEPIDOPTERA					x						x	
HEMIPTERA					x	x					x	x
OLIGOCHAETA				x				x		x	x	
ODONATA												x
PULMONATA											x	x
PELECYPODA												x
TRICLADIA											x	

One hundred eighty-seven fish of seven species, including trout, suckers, dace, and sculpins, were collected by electroshocking between Durango and the state line. No evidence of natural trout reproduction was found; all trout were identified as being planted fish or hatchery escapees. Limiting factors for fish in this area include high summertime water temperatures and an unstable substrate created by large amounts of sand and silt.

Electroshocking in the Animas River from Durango north to Baker Bridge yielded 401 fish of nine species, including trout, suckers, dace, and sculpin. Limited trout reproduction apparently does occur in this section.

Twelve tributary streams in the Study Area were also electrofished. The fish collected from these streams are included in Table 4. The Florida River contains excellent rainbow and brown trout populations from Lemon Reservoir to Highway 160. Below this point the increase in water temperature and addition of low quality return irrigation water decreases trout success and enhances nongame fish habitat. Junction Creek has very limited flow in the summer and fall, thereby inhibiting any trout fishery in the lower stretches. At higher elevations a trout fishery has been maintained with catchable rainbow plants. Hermosa Creek contains three species of trout; rainbows can be found anywhere on the stream with brook trout at lower elevations and cutthroat high on the drainage. Overall, the fishery is poor due to high, very turbid spring flood flows followed by a massive reduction in water volume. Lightner Creek contains the highest nongame fish populations of any tributary sampled. The trout captured there can be primarily attributed to hatchery escapees from the private unit located on the river. Reduced summer flows and poor quality water contribute to the reduced fisheries.

Population estimates have been calculated for the Animas River and selected tributaries. These estimates are presented in Table 4. In the Animas River, the estimates north of Durango are double those from south of Durango. This is a consequence of the difference in habitat between the two sections. The game fish estimates for the Animas River are extremely low relative to the size of the river, and the nongame fish populations are slightly higher than what is considered normal. The high game fish estimates in the Florida River can be attributed to increased productivity below the reservoir. However, the high population estimate for Junction Creek is misleading. The creek was sampled in the spring after the catchable plant but prior to harvest.

The entire Animas River has been managed with yearly catchable rainbow plants supplemented with periodic fingerling brown trout introduction since the early 1950's. The majority of these catchable fish are stocked between the Indian Reservation boundary below the Purple Cliffs and the Hermosa Creek confluence. The major tributaries have also been managed with catchables. Most of the smaller tributaries are planted from time to time with rainbow, cutthroat, and brook trout fry. Harvest patterns for various trout species removed from the Animas River and many of the important tributaries have been tabulated and are available through the Division of Wildlife, (Reference 10).

Aquatic Invertebrates

Invertebrate samples were collected on five different occasions from six main river stations. Samples were collected in 1975 and 1976. Additional samples were collected from Lightner and Junction Creeks and the Florida River during 1975. Compiled data by order and genera are presented in Table 5.

A total of 31 samples were collected from the six Animas River stations. Sampling was done at approximately three month intervals so all aquatic stages would be collected. Both numbers and diversity of invertebrates increased from Baker's Bridge downstream to Weaselskin Bridge, where the greatest number of invertebrates was found. This increase is primarily associated with rising water temperature. Below this point, the increased temperature and excessive siltation started to limit invertebrate production. There was also a definite change in species composition downstream which was attributed to the change in habitat from clear, cold water, and rock strata to warmer, turbid water, and sandy bottoms.

In general, the invertebrate population of the Animas River can be considered adequate for fish production. Insect populations are low at Baker's Bridge and could possibly become limiting to fish production; however, the blow out channelized conditions there are more detrimental than reduced food. The numbers and distributions of invertebrates species in the river system indicate introduction of organic pollutants and excessive silting in the lower areas.

The Florida River had the greatest variety of invertebrates of the three tributary streams sampled. The Florida River had eighteen different genera in its lower reaches and twenty-four in its upper reaches. Lightner Creek had the lowest diversity, with seven genera found in the upper end, and eight genera in the lower end. Junction Creek had nine different genera in its lower reaches and eleven genera in its upper reaches. Ecological factors affecting fish populations in the tributaries are believed to exert similar influences on invertebrate populations.

THREATENED AND ENDANGERED SPECIES

Authority for the management of threatened and endangered species in Colorado has been delegated to the State Division of Wildlife. In addition to protecting the animals themselves, this agency's objective is to encourage the protection of habitat considered essential to the survival and well-being of threatened and endangered species. One federally endangered, one federally threatened, and one state endangered species potentially occur within the Study Area.

The peregrine falcon has been federally classified as endangered. It is known to exist in the vicinity of the Study Area and one pair of birds was observed west of Durango in 1974 and 1975. Requirements for suitable eyries are precipitous cliffs having several ledges, potholes, or small caves in the cliff face to serve as suitable nest sites. Hunting habitat includes areas which serve to concentrate or support prey species (primarily small to moderate sized birds) and must provide suitable prey exposure for aerial attacks. In the Study Area the Animas River Valley provides both of these criteria.

The bald eagle, federally classified as threatened, is a common winter resident of the area. The preferred habitat of this species is along streams and at large lakes and reservoirs.

The lynx is classified as endangered by the state of Colorado. It is a secretive predator primarily found in spruce-fir forests above 9500 feet. Colorado Division of Wildlife distribution maps indicate lynx may occur in the mountains north of Durango. These animals have large ranges and may occasionally wander into the Study Area.

Currently, there are no known threatened or endangered species of plants in the Study Area.

SURFACE WATER QUALITY

Sources for surface and groundwater quality data include Colorado Department of Health, (References 12, 13). U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS) and the Colorado Department of Water Resources. The most comprehensive surface water data are available from EPA's STORET system but this source has information only for the Animas River. Other surface water data sources provide information of varying quantity and comprehensiveness. Data pertaining to groundwater quality in the Study Area are limited and incomplete. Groundwater quality data are available only from USGS and EPA.

Water Quality Standards

The state water quality criteria and stream classification system were used to assess the water quality of the Study Area. The State of Colorado promulgated water quality criteria which became effective on 20 July 1978, (Reference 11). These criteria are intended to maintain and improve the quality of the waters of the State. Colorado water quality criteria are shown in Table 6.

The classifications, standards, and criteria were established with the best available knowledge to insure the suitability of Colorado's waters for the following beneficial uses: water supply; domestic, agricultural, industrial, and recreational uses; and the protection and propagation of terrestrial and aquatic life. They are further intended to be consistent with the Federal Water Pollution Act Amendments of 1972 and the Clean Water Act of 1977.

TABLE 6

COLORADO WATER QUALITY CRITERIA

PARAMETER	Recreational		Aquatic Life		Agriculture		
	Class 1 Primary Contact	Class 2 Secondary Contact	Cold Water Biots	Warm Water Biots	Agriculture	Class 1 Ground Water	Class 1 Raw Waters
PHYSICAL							
D.O (mg/l) (1)	Aerobic (2)	Aerobic (2)	6.0 (3) 7.0-Spawn	5.0	Aerobic (2)	Aerobic (2)	Aerobic (2)
pH (Std. Units)	6.5-9.0	X	6.5-9.0	6.5-9.0	X	5.0-9.0	5.0-9.0
Suspended Solids (mg/l) & Turbidity (TU)	(4)	(4)	(4)	(4)	(4)	1.0 TU	(4)
Temperature (°C)	X	X	Max (20 C) w/3 C Increase (5)	Max 30 C w/3 C Increase (5)	X	X	X
TDS (mg/l)	X	X	Y	Y	Y	Y	Y
BIOLOGICAL							
Algae (6)	FF Obj. & Toxic	FF Obj. & Toxic	FF Obj. & Toxic	FF Obj. & Toxic	FF Obj. & Toxic	FF Obj. & Toxic (8)	FF Obj. & Toxic
Fecal Coliforms per 100 ml (Geometric mean)	200	1000	X	X	1000	0 (7)	1000

(1) Where dissolved oxygen levels, less than the standard, occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

(2) An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/liter dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

(3) A 7 mg/liter standard, during periods of spawning of coldwater fish, shall be set on a case by case basis as defined in the NPDES permit for those dischargers whose effluent would affect fish spawning.

(4) Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

(5) Temperature shall maintain a normal pattern of diurnal and seasonal fluctations with no abrupt changes and shall have no increase in temperature of a magnitude, rate and duration deemed deleterious to the resident aquatic life. Generally, a maximum 3°C increase over a minimum of a 4-hour period, lasting for 12 hours maxim, is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using BMP, BATEA, and BPWTT control measures, the Division will determine whether the resulting temperature increases preclude an Aquatic Life classification.

(6) Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

(7) For drinking water with or without disinfection.

COLORADO WATER QUALITY CRITERIA (Continued)

PARAMETER	Recreational		Aquatic Life						Agriculture	Water Supply	
	Class 1 Primary Contact	Class 2 Secondary Contact	Cold Water and Warm Water Biota or Water Hardness (mg/l)[(1)]					Bioassay (Application or other)[(2)]	Agriculture	Class 1 Ground Water	Class 2 Raw Water
TOXIC METALS Total conc. in mg/l			0 to 100	100 to 200	200 to 300	300 to 400	400 plus				
Aluminum (soluble)	X	X	0.1	0.1	0.1	0.1	0.1	Bioassay	X	X	X
Arsenic	X	X	0.05	0.05	0.05	0.05	0.05	Bioassay	0.1	0.05	0.05 Bario
Barium	X	X	X	X	X	X	X		X	1.0	1.0 Beryll
Beryllium	X	X	0.01	0.3	0.6	0.9	1.1	Bioassay	0.1	X	X Cadmuium
Cadmium	X	X	0.0004	0.001	0.005	0.010	0.015	Bioassay	0.01	0.010	0.010
Chromium	X	X	0.1	0.1	0.1	0.1	0.1		0.1	0.05	0.05
Copper	X	X	0.01	0.01	0.01	0.02	0.04	0.1AF	0.2	1.0	1.0
Iron	X	X	1.0	1.0	1.0	1.0	1.0		X	0.3(sol)	0.3(sol)
Lead	X	X	0.004	0.025	0.050	0.100	0.150	Bioassay[(3)]	0.1	0.05	0.05
Manganese	X	X	1.0	1.0	1.0	1.0	1.0	Bioassay	0.2	0.05(sol)	0.05(sol)
Mercury	X	X	0.00005	0.00005	0.00005	0.00005	0.00005		X	0.002	0.002
Molybdenum	X	X	X	X	X	X	X		Y	Y	Y
Nickel	X	X	0.05	0.10	0.20	0.30	0.40	0.01AF	0.2	X	X
Selenium	X	X	0.05	0.05	0.05	0.05	0.05	0.1AF	0.02	0.01	0.01
Silver	X	X	0.00010	0.00010	0.00015	0.00020	0.00025	0.01AF	X	0.05	0.05
Thallium	X	X	0.015	0.015	0.015	0.015	0.015	Bioassay	X	X	X
Uranium[(5)]	X	X	0.03	0.02	0.4	0.8	1.4	Bioassay	(5)	(5)	(5)
Zinc	X	X	0.05	0.05	0.10	0.30	0.60	0.01AF	2.0	5.0	5.0

(1) Concentrations of total alkalinity or other chelating agents attributable to municipal, industrial or other discharges or agricultural practices should not alter the total alkalinity or other chealting agents of the receiving water by more than 20%. Where the complexing capacity of the receiving water is altered by more than 20% or where chelating agents are released to the receiving water which are not naturally characteristic of that water, specific effluent limitations on ertinent arameters will be established. In no case shall instream modification or alteration of total alkalinity or other chelating agents be permitted without Commission authorization.

(2) Where indicated, bioassay procedures may be used to established criteria or standards for a particular situation.

(3) For bioassay lead concentration is based on soluble lead measurements (i.e. non-filterable lead using a 0.45 micron filter).

(4) The appropriate value for molybdenum depends on many factors, such as soil type, crop and irrigation practices. A numerical value for molybdenum will be assigned on a case by case basis.

(5) Uranium is listed in Table II for its toxicological properties to aquatic life, and also in Table V (Radiologicals) for limitations on other uses.

COLORADO WATER QUALITY CRITERIA (Continued)

PARAMETER	Recreational Class 1 Primary Contact	 Class 2 Secondary Contact	Aquatic Life Cold Water Biota	 Warm Water Biota	Agriculture Agriculture	Class 1 Ground Water	Class 1 Raw Water
INORGANICS							
Ammonia (mg/l as N)	X	X	0.02 unionized	0.10 unionized	X	0.5	0.5[1]
Total residual Chlorine (mg/l)	X	X	0.002	0.01	X	X	X
Cyanide (mg/l)	X	X	0.005	0.005	0.2	0.2	0.2
Fluoride (mg/l)	X	X	X	X	X	(2)	(2)
Nitrate (mg/l as N)	X	X	X	X	100[3]	10	10
Nitrite (mg/l as N)	X	X	0.05	0.5	10[3]	1.0	1.0
Sulfide as H_2S(mg/l)	X	X	0.002 undissociated	0.002 undissociated	X	0.05	0.05
Boron (mg/l)	X	X	X	X	0.75	X	X
Chloride (mg/l)	X	X	X	X	X	250	250
Magnesium (mg/l)	X	X	X	X	X	125	125
Sodium Adsorption Ratio	X	X	X	X	X	X	X
Sulfate (mg/l)	X	X	X	X	X	250	250
Phosphorus[4] (mg/l as P)	Bioassay [4]	Bioassay [4]	Bioassay [4]	Bioassay [4]	X	Bioassay[4]	Bioassay(4)

(1) Because ammonia may be indicative of pollution and because of its significant effect on chlorination, it is recommended that ammonia nitrogen in public water suppply sources not exceed 0.5 mg/l.

(2) Fluoride limits vary from 2.5 mg/l at 12.0 C and below, to 1.4 mg/l between 26.3 C and 32.5 C, based upon the annual average of the maximum daily air temperature (see "National Interim primary drinking water regulations for specific limitations", or any modification thereto).

(3) In order to provide a reasonable margin of safety to allow for unusual situations such as extremely igh water ingestion or nitrite formation in slurries, the NO_3-N plus NO_2N content in drinking waters for livestock and poultry should be limited to 100 ppm or less, and the NO_2-N content alone be limited to 10 ppm or less.

(4) Phosphorous criteria or standards are to be determined by an algal bioassay using the method described in the latest edition of "Standard Methods for the Examination of Water and Wastewater", American Public Health Association.

COLORADO WATER QUALITY CRITERIA (Continued)

PARAMETER	Recreational		Aquatic Life	Agriculture		
	Class 1 Primary Contact	Class 2 Secondary Contact	Cold Water Biota and Warm Water Biota	Agriculture	Class 1 Ground Water	Class 1 Raw Water
ORGANIC (1) (mg/l)						
Chlorinated Pesticides (2)						
Aldrin (3)	Y	Y	0.000003 (4)	Y	Y	Y
Chlordane (3)	Y	Y	0.00001	Y	Y	Y
Dieldrin (3)	Y	Y	0.000003 (4)	Y	Y	Y
DDT (3)	Y	Y	0.000001	Y	Y	Y
Endrin	Y	Y	0.000004	Y	0.0002	0.0002
Heptachlor (3)	Y	Y	0.000001	Y	Y	Y
Lindane	Y	Y	0.00001	Y	0.004	0.004
Methoxychlor	Y	Y	0.00003	Y	0.1	0.1
Mirex	Y	Y	0.000001	Y	Y	Y
Toxaphene	Y	Y	0.000005	Y	0.005	0.005
Orthophosphate Pesticides (2)						
Demeton	Y	Y	0.0001	Y	Y	Y
Endosulfan	Y	Y	0.000003	Y	Y	Y
Guthion	Y	Y	0.00001	Y	Y	Y
Malathion	Y	Y	0.0001	Y	Y	Y
Parathion	Y	Y	0.00004	Y		
Chlorophenoxys (Herbicides)						
2,4-D	Y	Y	Y	Y	0.1	0.1
2,4,5-TP	Y	Y	Y	Y	0.01	0.01
PCB (Polychlorinated Biphenyls) (5)	Y	Y	0.000001	Y	Y	Y(5)
Phenol	Y	Y	0.001	Y	0.001	0.001

---

(1) All organics, not on this partial list, are covered under Basic Standards.

(2) Numerical values in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

(3) The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposure to a minimum (EPA).

(4) Aldrin and dieldrin in combination should not exceed 0.000003 mg/l.

(5) Every reasonable effort should be made to minimize human exposure (EPA).

COLORADO WATER QUALITY CRITERIA (Continued)

PARAMETER	Recreational		Aquatic Life	Agriculture		
	Class 1 Primary Contact	Class 2 Secondary Contact	Cold Water Biota and Warm Water Biota	Agriculture	Class 1 Ground Water	Class 1 Raw Water
conc. in Picocuries per liter (pCi/l)(1)						
RADIOLOGICAL						
Alpha (2) (excluding uranium & radon)	X	X	15	15	15	15
Beta (2) (excluding strontium 90)	X	X	50	50	50	50
Cesium, 134	X	X	80	80	80	80
Plutonium 238, 239, & 240	X	X	15	15(G)	15	15
Radium, 226 & 228 (3)	X	X	5	5	5	5
Strontium 90 (3)	X	X	8	8	8	8
Thorium, 230 & 232	X	X	60	60	60	60
Tritium	X	X	20,000	20,000 (E)	20,000	20,000
Uranium (total)	X	X		5 mg/l (9)	5 mg/l (9)	5 mg/l (9)

(1) Concentrations given are maximum permissible concentrations above naturally occurring or "backgrdound" concentrations excet where otherwise noted.

(2) If Alpha or Beta are measured in excess of 15 or 50 pCi/l resectively, it will be nncessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated leve. Particular radionuclides should not exceed the value given in the table. If an elevated level of Alpha or Beta emmissions is caused by radionuclides, the Division should be consulted.

(3) Maximum permissible concentrations including naturally occurring or background contributions.

WATER QUALITY STANDARDS SUMMARY

Standard	Class			
	A_1	A_2	B_1	B_2
Settleable Solids	Free From	Free From	Free From	Free From
Floating Solids	Free From	Free From	Free From	Free From
Taste, Odor, Color	Free From	Free From	Free From	Free From
Toxic Materials	Free From	Free From	Free From	Free From
Oil and Grease	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration
[illegible]	[illegible]	[illegible]	[illegible]	Drinking Water Standards
[illegible]	[illegible]	[illegible]	[illegible]	Geometric Mean of [illegible] from five samples in 30-day per[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	No increase more than 10 J.T.U.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] mg/l minimum
[illegible]	[illegible]	[illegible]	[illegible]	6.0 - 9.0 Maximum 90°F Maximum Change: streams < 5°F lakes < 3°F
[illegible]	[illegible]	[illegible]		

Animas River

Water quality data on the Animas River are available from the Colorado Department of Health and from EPA. Water quality of the Animas River has been monitored at nine stations within or adjacent to the Study Area. Water quality monitoring stations are located on Figure 7. Data collected at these stations are presented in Table 7. All but one of the monitoring stations (station 66) are located within the original Study Area.

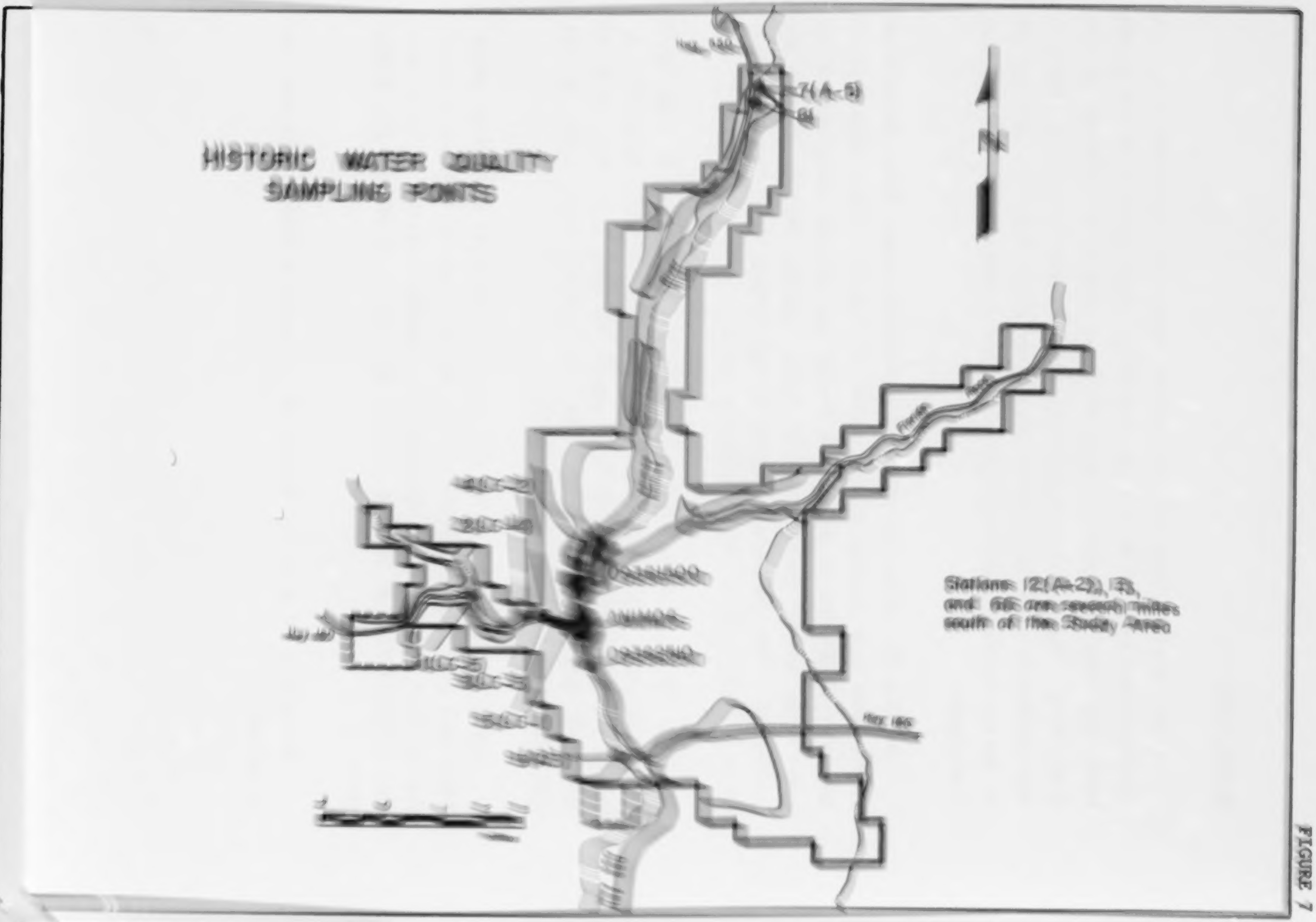
Station 66, while not within the original Study Area, is included in the data base because of its period of record. Also, comparison of data between station 31 at Baker's Bridge and station 66 at Bondad can provide an overall perspective of water quality changes through the Study Area. The remaining stations on the Animas River aid in identifying the locations of water quality changes.

Most of the Animas River surface water information is from EPA's STORET system. Data from studies done by the Colorado Department of Health are limited. There is duplication of data among Department of Health documents, and no more than two samples were taken by the Department from any one sampling station.

The existing water quality data base is comprised of various parameters monitored during different time periods, and is generally inconsistent both spatially and temporarily. However, based on these data some conclusions can be made on the quality of water in the Animas River.

Evaluation of data for station 31 at Baker's Bridge indicates the following:

FIGURE 7



HISTORIC WATER QUALITY SAMPLING POINTS

7(A-5)
8
N
09364500
ANIMAS
09365000

Stations 12(A-2), 13, and 66 are several miles south of the Study Area

TABLE 7

WATER QUALITY DATA

ANIMAS RIVER

PARAMETER	STATION					
	81			09361500		
	Mean	Max.	Min.	Mean	Max.	Min.
Temperature, °C	5.4	16.1	0	9.94	17	3.6
Dissolved Oxygen, mg/1	10.57	12.2	7.4	9.2		
pH, units	7.9	8.9	6.9	8.4		
Total Alkalinity, mg/1	44	44	44	56		
Total Hardness, mg/1	150.6	263	59	95.0		
Calcium Hardness, mg/1	118.7	238	9.8	32.0		
Magnesium Hardness, mg/1	7.3	23	2	3.6		
Total Solids, mg/1	213	258	119			
TDS, mg/1	196.24	370	79	124.0		
Conductivity, u mhos	285.5	467.00	130.0	491.8	770	223
Sodium, mg/1	3.26	13	1	2.0		
Chloride, mg/1	4.34	12	1	40.0		
Sulfates, mg/1	99.78	230	25			
Turbidity, FTU	8.07	18	1			
Nitrate, mg/1	0.167	0.8	0	0.09		
Nitrite, mg/1	0.003	0.0033	0			
Ammonia-N, mg/1	0.08	0.72	0			
Ortho Phosphate, mg/1				0.03		
Total Phosphate, mg/1	0.075	0.25	0			
Total Phosphorus, mg/1	0.058	0.23	0	0.01		
BOD, mg/1	1.32	8	0			
Total Coliform, MPN/100 ml	1175.5	2400	2			
Fecal Coliform, MPN/100ml	79.48	2200	0			
Aluminum mg/1						
Arsenic mg/1	0					
Cadmium mg/1	0.00016	0.0003		0.07		
Chromium mg/1	0					
Copper mg/1	0.0094	0.062		1.8		
Iron mg/1	0.596	2.7		45		
Lead mg/1	0.0158	0.125				
Manganese mg/1	0.259	0.81		52		
Mercury mg/1				0.004		
Molybdenum mg/1	0.00075	0.0001				
Nickel mg/1						
Selenium mg/1	0					
Silver mg/1	0			0.06		
Zinc mg/1	0.233	0.74	16			

TABLE 7 (Continued)

PARAMETER	STATION					
	ANIM06			09362510		
	Mean	Max.	Min.	Mean	Max.	Min.
Temperature, °C	8.9	17.8	0.6	10.4	2.3	1
Dissolved Oxygen, mg/l				8.8	11.4	6.5
pH, units				7.9	8.7	7.2
Total Alkalinity, mg/l	121.5	207	6			
Total Hardness, mg/l						
Calcium Hardness, mg/l	94.7	425	8.4			
Magnesium Hardness, mg/l	12.04	61	1.6			
Total Solids, mg/l						
TDS, mg/l	360	1,548	104			
Conductivity, u mhos	428.7	640	150	748	4,800	180
Sodium, mg/l	14.06	44	1.4			
Chloride, mg/l	5.56	25.5	0.5			
Sulfates, mg/l	115.78	600	19			
Turbidity, FTU						
Nitrate, mg/l						
Nitrite, mg/l						
Ammonia-N, mg/l						
Ortho Phosphate, mg/l						
Total Phosphate, mg/l						
Total Phosphorus, mg/l						
BOD, mg/l						
Total Coliform, MPN/100 m/				882.5	4,500	80
Fecal Coliform, MPN/100m/				92.6	500	0
Aluminum						
Arsenic						
Cadmium						
Chromium						
Copper	0.116	1.5				
Iron	1.124	8.6				
Lead	0.085	1.0				
Manganese	0.494	7.7				
Mercury						
Molybdenum						
Nickel						
Silver						
Zinc	0.33	1.16				

TABLE 7 (Continued)

PARAMETER	STATION		
	66		
	Mean	Max.	Min.
Temperature, °C	8.8	21.1	0
Dissolved Oxygen, mg/l	10.1	12.6	8.0
pH, units	8.3	9.1	7.3
Total Alkalinity, mg/l	92.7	130	54
Total Hardness, mg/l	219.9	369	80
Calcium Hardness, mg/l	174.1	267	64
Magnesium Hardness, mg/l	11.34	36	4
Total Solids, mg/l	421.5	764	192
TDS, mg/l	330	544	109
Conductivity, u mhos	486.7	860	170
Sodium, mg/l	19.9	41	2
Chloride, mg/l	19.9	40	4
Sulfates, mg/l	119.2	190	38
Turbidity, FTU	68.6	1 100	1.8
Nitrate, mg/l	0.313	4.7	0
Nitrite, mg/l	0.008	0.0033	0
Ammonia-N, mg/l	0.08	1.02	0
Ortho Phosphate, mg/l	0.05		
Total Phosphate, mg/l	0.179	0.6	0
Total Phosphorus, mg/l	0.07	0.41	0
BOD, mg/l	1.76	6	0.7
Total Coliform, MPN/100 ml	1 268	2 400	2.2
Fecal Coliform, MPN/100ml	511	2 400	2
Aluminum	2.8		
Arsenic			
Cadmium	0.00008	0.0036	
Chromium	0		
Copper	0.0111	0.210	
Iron	0.755	12.0	
Lead	0.0295	0.56	
Manganese	0.1149	1.2	
Mercury			
Molybdenum	0.00045	0.0001	
Nickel	0		
Selenium	0.0003	0.0004	
Silver	0		
Zinc	0.0684	0.680	

TABLE 7 (Continued)
STATION

PARAMETER	7(A-5)		9-(A-3)		12(A-2)		13	
	7-74	9-74	7-74	9-74	7-74	9-74	7-74	9-74
Temperature, °C	14	14	19	17	18	16	17	16
Dissolved Oxygen, mg/l	8.9	8.3	8.2	10.3	8.4	9.5	8.2	8.7
pH, units	8.4	8.3	8.4	8.7	8.3	7.9	8.5	7.2
Alkalinity, mg/l	20	32	104	228	100	200	120	208
Phenolphthalein Alkalinity, mg/l	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hardness, mg/l	92	228	188	360	184	360	184	348
Calcium Hardness, mg/l	92	172	156	324	148	340	152	312
Magnesium Hardness, mg/l	0.0	14	8.0	9.0	9.0	4.8	8.0	9.0
Total Solids, mg/l	15.5		314		342		352	
TDS, mg/l	146	270	304	557	290	530	304	515
Conductivity, u mhos	216	390	455	850	435	800	440	775
Sodium, mg/l	2	2	20	58		58	20	57
Chloride	4	4	36	10	48	20	26	12
Sulfates	78	170	0	190	98	170	48	160
Turbidity,	5	2.1	4	2.3	14	3.0	18	3.3
Nitrate	0.0		0.0		0.0		0.0	
Nitrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ammonia	0.0	0.5	0.3	0.5	0.0	0.4	0.0	0.6
Ortho Phosphate	0.0		0.0		0.0		0.0	
Total Coliform		0		160				
Fecal Coliform		0		0				
Fecal Streptococcal		0		0				

1. The mean dissolved oxygen (DO concentration of the stream, 10.57 mg/l, is well above the minimum state standard of 6.0 mg/l. The minimum DO concentration of 7.4 mg/l is also above the minimum state standard. Using standard methods the DO saturation level at the stream's mean temperature of 5.4°C is approximately 12.7 mg/l. At the maximum stream temperature of 16.1°C, the DO saturation level is approximately 10.0 mg/l; the minimum DO level recorded was 7.4 mg/l. These statistics indicate that the stream segment has a background oxygen demand resulting in a seventeen to twenty-six percent depletion of DO below saturation.

2. Temperature and pH at this station, both maximum and minimum values, are within State standards.

3. The fecal coliform bacteria standard is generally met. The standards for fecal coliform require the geometric mean to be less than 1,000/100 ml from five samples in a 30-day period. No such data is recorded in STORET. However, the arithmetic mean of 79/100 ml for all samples is below the standard. The highest recorded value of 2,200/100 ml exceeds the standard, and the fecal coliform bacteria standard may be occasionally violated at this station. Sources of fecal coliform include nonpoint source runoff from rangeland, septic tanks, and mechanical wastewater treatment facilities.

4. This segment of the Animas River meets standards of settleable solids, floating solids, taste, odor, color, oil and grease, and turbidity.

5. A review of the metals data indicates that there are no violations at this station of the standards for arsenic, cadmium, chromium, manganese, molybdenum, selenium, or silver. Copper, iron, and lead standards are not violated by the mean reported concentrations, but the maximum reported values are above the State limits. Zinc concentrations are above the standard both in mean and maximum values reported. Thus, copper, iron, and lead concentration violations are occasional, whereas zinc concentration violations are more frequent. No data are available on any other metals.

6. Nutrient levels of the stream at Baker's Bridge appear low to moderate, with nitrate reaching a maximum of 0.8 mg/l.

7. Ammonia concentrations reach a maximum value of 0.72 mg/l. Taking the worst case conditions for temperature and pH, this converts to twenty-three percent unionized ammonia.

8. This station shows total water hardness to be moderate (150.6 mg/l); conductivity (285.5 mhos) is also considered moderate.

9. Total solids and total dissolved solids have moderate concentrations, with the mean of each being approximately 200 mg/l.

10. Sodium and chloride concentrations are low (3.26 mg/l and 4.34 mg/l, respectively) at this station, and the sulfate concentration (99.78 mg/l) is moderate.

Changes in quality of the Animas River water as it flows through the Study Area can be determined by comparison of the water quality at station 81 and station 66. Station 66 is located immediately below the confluence of the Florida and Animas Rivers. Water quality data are available for both rivers prior to their confluence, and indicate that both rivers have similar water quality. A comparison of Animas River water quality above and below the Florida River confluence indicates there is no significant impact from the Florida River discharge. Evaluation of the data from station 66 indicates the following:

1. DO concentrations - both the mean of 10.1 mg/l and the minimum of 8 mg/l - are well above the minimum state standard of 6 mg/l. Saturation levels for the mean and maximum temperatures of 8.8°C and 21.1°C, respectively, are approximately 11.6 mg/l and 9.0 mg/l. These statistics show the existing demand on dissolved oxygen results in a twelve to thirteen percent depletion below saturation.

2. The mean temperature and pH at this station are well under the allowable. The maximum values of both, however, exceed the state standard. The minimum pH is acceptable. Thus, temperature and pH standards are occasionally violated.

3. The fecal coliform bacteria standard is occasionally violated. The limitations of evaluating this parameter have been previously discussed. The mean value of fecal coliforms has increased significantly from the value at station 81 (from 79/100 ml to 511/100 ml). The maximum value reported, 2,400/100 ml, also shows an increase.

Since the mean value shows a significant coliform contribution, and the maximum value is twice the standard, it is possible that violations of the standard are not uncommon.

4. This segment of the Animas River meets standards for settleable solids, floating solids, taste, odor, color, oil and grease, and turbidity.

5. A review of the metals criteria indicates there are no violations of the standards for cadmium, chromium, molybdenum, selenium, or silver. Copper, iron, lead, and manganese standards are not violated by the mean reported concentrations, but the maximum reported values are above the limit. Zinc concentrations are above the standard, both in mean and maximum values reported. Copper, iron, lead, and manganese concentration violations are probably occasional, while zinc concentration violations are probably more frequent. No data are available on any other metals. Except for an increase in the amount of manganese, concentrations of metals do not change significantly between stations 81 and 66.

6. Water hardness and conductivity both have higher values at this station than at station 81. Mean and maximum hardness values for station 81 are 150.6 mg/l and 263 mg/l, respectively, while station 66 recorded mean and maximum hardnesses are 219.9 mg/l and 369 mg/l, respectively. This represents approximately a seventy percent increase. Conductivity increased over 60 percent, from 285.5 micro mhos to 486 micro mhos for the mean values and from 467 micro mhos to 860 micro mhos for the maximum values.

7. Nutrient levels at station 66 are much higher than those at Baker's Bridge. Nitrite values remain about the same, but the nitrate mean value doubles and the nitrate maximum value increases six fold, to 0.313 mg/l and 4.7 mg/l, respectively. These parameters, along with turbidity, which quadruples, seem to indicate degradation of water quality between station 81 and station 66.

8. The ammonia mean values indicate no change, but the maximum increases by approximately thirty percent. Assuming worst case conditions for temperature and pH at this station, this converts to thirty percent unionized ammonia.

9. Total solids and dissolved solids concentrations show a significant increase from the upstream station of sixty to one hundred percent, respectively.

10. Chloride and sodium concentrations increased approximately four and five fold, respectively, from station 81 to station 66. This is an indication that wastewater discharges have significant impacts on water quality. The sulfate concentrations increased only slightly.

Data from STORET monitoring stations 90361500, ANIMOG, and 9036251 were considered only marginally useful either because the data were incomplete or because the data were over ten years old. Data from three Colorado Department of Health sampling stations were considered marginal for the same reasons. However, some trends were identified using data from these stations.

Comparing data, the following trends are identified:

1. Mean temperature increases of approximately sixteen percent occur before Lightner Creek joins the Animas River. After the confluence of the Animas River and Lightner Creek, the mean temperature varies only slightly, but the maximum temperature of the river increases fifteen percent. By the time the waters reach station 66, the temperatures, both mean and maximum, have decreased. These temperature increases are probably attributable to natural heating of the waters from runoff.

2. The pH level of the stream remains within the standards as it flows through the city of Durango, and remains in compliance at station 66.

3. The DO concentration remains in compliance as the river passes through the city of Durango. The demand on the oxygen capacity of the river rises to over twenty-one percent of saturation as it reaches the downstream outskirts of the city of Durango.

4. Conductivity of the river increases by approximately sixty percent before the confluence of the Animas River and Lightner Creek. Conductivity increases by another sixty-five percent as the river travels through the city of Durango. By the time the waters reach station 66, conductivity has decreased approximately sixty-five percent from the mean value recorded at the southern edge of the city of Durango.

5. Total coliforms have increased five fold by the time the river has passed through the city of Durango. Coliform concentrations continue to increase from there to station 66.

6. Fecal coliforms increase as the stream passes through the City of Durango. Concentrations continue to increase as the stream flows to station 66.

7. Data are sparse with regard to metal concentrations, but copper, iron, manganese, lead, and zinc all seem to increase in concentration as the waters move downstream.

Lightner Creek

A special study of Lightner Creek was performed for the Colorado Department of Health, Water Quality Control Division, in 1974, (Reference 13). This study was later incorporated into the San Juan River water quality management plan, (Reference 12). The results of one sampling at five stations along the creek are presented in Table 8. The locations of the sampling points are presented in Figure 7 along with the approximate locations of known discharges. Although one sample provides insufficient data from which to base concrete conclusions, some general trends can be noted.

1. The DO concentration of the stream appears to be at an acceptable level. No specific trend of oxygen demand can be observed.

2. Temperature does not violate the standard. Station 5 (LC-1), which is located immediately upstream of the confluence with the Animas River has the highest temperature. This rise in temperature is probably attributable to natural warming from runoff.

TABLE 8

WATER QUALITY DATA

LIGHTNER CREEK

PARAMETER	STATION 1(LC-5)	 2(LC-4)	 3(LC-3	 4(LC-2)	 5LC-1)
Temperature, °C	15	12	17	15	19
Dissolved Oxygen, mg/1	7.7	8.6	7.9	7.7	8.4
pH, units	8.3	8.4	8.1	7.9	8.2
Total Alkalinity, mg/1	204	208	228	252	228
Phenolphthalein Alkalinity, mg/1	0	0	0	0	0
Total Hardness, mg/1	316	348	392	392	450
Calcium Hardness, mg/1	300	340	376	380	310
Magnesium Hardness, mg/1	4.0	2.0	4.0	3.0	34.0
TDS, mg/1	340	365	490	475	500
Conductivity, u mhos	560	600	750	820	750
Sodium, mg/1	11	15	20	26	27
Chloride, mg/1	4.0	4.0	4.0	4.0 48	4.0
Sulfates, mg/1	85	140	200	240	240
Turbidity, F	0.6	1.2	4.0	8.0	13.0
Nitrate, mg/1	0.4	0	0	2.0	2.8
Nitrite, mg/1	0	0.02	0	0.01	0
Ammonia, mg/1	0	0	0	0.4	0.4
Ortho Phosphate, mg/1	1.4	1.0	0	0.8 0	0.8
Total Phosphate, mg/1	1.4	1.0	0.4	1.4	1.6
Total Phosphorus, mg/1	0.46	0.33	0.13	0.46	0.52
Total Coliform, MPN/100 ml	1560	5300	72,000	76,000	100,000
Fecal Coliform, MPN/100ml	20	40	7,200	53,000	52,000
Fecal Streptococcal, MPN/100ml	0	30	300	1,000	730

3. Total coliform bacteria shows an increase going downstream toward the confluence with the Animas River. The total coliform concentration increases over sixty fold between station 1 (LC-5) and station 5 (LC-1), with the biggest increase occurring between station 2 (LC-4) and station 3 (LC-3). This large total coliform increase probably affects the Animas River water quality.

4. Fecal coliform bacteria also shows a marked increase going downstream. Station 1 (LC-5) has a fecal coliform concentration of 20/100 ml, and station 5 (LC-1) has a concentration of 52,000/100 ml. The greatest increase occurs between station 2 (LC-4) and station 3 (OC-3). This increase in fecal coliform probably affects the Animas River water quality.

5. Total hardness tends to increase as the creek flows downstream. Increases in calcium and magnesium were also noted.

6. Conductivity tends to increase downstream.

7. Sodium and sulfates both increase downstream, with sulfates showing the greater change. The increase in sulfates is an indicator that waste water discharges into the creek are measurable. Chloride values remain constant.

8. Turbidity increases markedly as the creek flows toward the confluence. This is an indicator of possible degradation of the waters.

9. Nutrients (nitrite and nitrate) generally increase as the creek flows toward the confluence, with nitrate appearing as the more significant nutrient. The increase of nutrients is an indication of degradation of the waters.

It is probable that Lightner Creek has an adverse impact on the Animas River's water quality for the following parameters; temperature, total and fecal coliform concentrations, hardness, conductivity, turbidity, sulfates, and nutrients. The 1974 special study indicates that the degraded quality of Lightner Creek could probably be linked to the nine dischargers located on the creek.

Hermosa Creek

Only one sample of Hermosa Creek water was taken by the Colorado Department of Health. These data are presented in Table 9. A single sample at a single location yields insufficient data for valid water quality evaluation. However, the creek was not in compliance with temperature standards during the 1974 monitoring. All other parameters were within standard limits.

Junction Creek

No data were available for the evaluation of water quality of this creek.

Florida River

Water quality of the Florida River was monitored for the Colorado Department of Health in 1974. Two samples were taken at two locations

TABLE 9

WATER QUALITY DATA

HERMOSA CREEK

PARAMETER	DATE 7-25-74
Temperature (°C)	22
Dissolved Oxygen, mg/1	7.7
pH, Units	8.6
Total Alkalinity, mg/1	60
Phenolphtalein Alkalinity, mg/1	8
Total Hardness, mg/1	184
Calcium Hardness, mg/1	152
Magnesium Hardness, mg/	8.0
Total Solids, mg/1	261
Total Dissolved Solids, mg/1	274
Conductivity u mhos	370
Sodium, mg/1	4
Chloride, mg/1	8
Sulfates, mg/1	111
Turbidity FTU	4
Nitrate, mg/1	0
Nitrite, mg/1	0
Ammonia, mg/1	0
Ortho Phosphate mg/1	0
Arsenic mg/1	0
Cadium mg/1	0
Copper mg/1	0
Iron mg/1	0
Lead mg/1	0
Zinc mg/1	0.05

over a period of two months. The results of the monitoring are presented in Table 10. Data are insufficient to draw conclusions, but some inferences can be made when comparing Florida River water quality with that of the Animas River at station 66.

1. Temperature of the Florida River is occasionally in violation of the State standard. This might affect the Animas River if the violations are frequent, although causes are probably natural.

2. The DO concentration is well above the standard, and the oxygen demand depresses the dissolved oxygen concentration less than ten percent below saturation. This oxygen demand value is less than that found in the Animas River above and below the confluence.

3. The pH of the Florida River is similar to that of the Animas River and is in compliance with water quality standards.

4. Total alkalinity of the Florida River is approximately twice that of the Animas River.

5. Hardness of the Florida River is generally less than that of the Animas River.

6. Solids concentrations appear to be less in the Florida River than in the Animas River.

TABLE 10

WATER QUALITY DATA

FLORIDA RIVER

PARAMETER	STATION I.D.	Date 7-25-74	 9-12-74
Temperature, °C	F-1	21	17
	F-2	20	16
Dissolved Oxygen, mg/l	F-1	8.4	9.6
	F-2	9.3	9.0
ph, Units	F-1	8.7	8.5
	F-2	8.5	8.1
Total Alkalinity, mg/l	F-1	180	200
	F-2	232	248
Phenolphthalein Alkalinity, mg/l	F-1	12	0
	F-2	0	0
Total Hardness, mg/l	F-1	160	240
	F-2	220	296
Calcium Hardness, mg/l	F-1	124	188
	F-2	160	276
Magnesium Hardness, mg/l	F-1	7.0	13.0
	F-2	15.0	5.0
Total Solids, mg/l	F-1	337	
	F-2	286	
Total Dissolved Solids, mg/l	F-1	249	290
	F-2	282	290
Conductivity, u mhos	F-1	385	500
	F-2	495	500
Sodium, mg/l	F-1	28	45
	F-2	16	16
Chloride, mg/l	F-1	34	20
	F-2	14	6
Sulfates, mg/l	F-1	29	35
	F-2	35	25
Turbidity, FTU	F-1	33	1.4
	F-2	3	0.7
Nitrate, mg/l	F-1	0	
	F-2	0	
Nitrite, mg/l	F-1	0	0
	F-2	0	0
Ammonia, mg/l	F-1	0.3	0.7
	F-2	0	0.4
Ortho Phosphate, mg/l	F-1	0	
	F-2	0	

7. Sodium and chloride concentrations are higher in the Florida River than in the Animas River, but sulfate concentrations are lower. Sodium and chloride concentrations are not increased enough to be valid indicators of measurable wastewater discharges, (Reference 16).

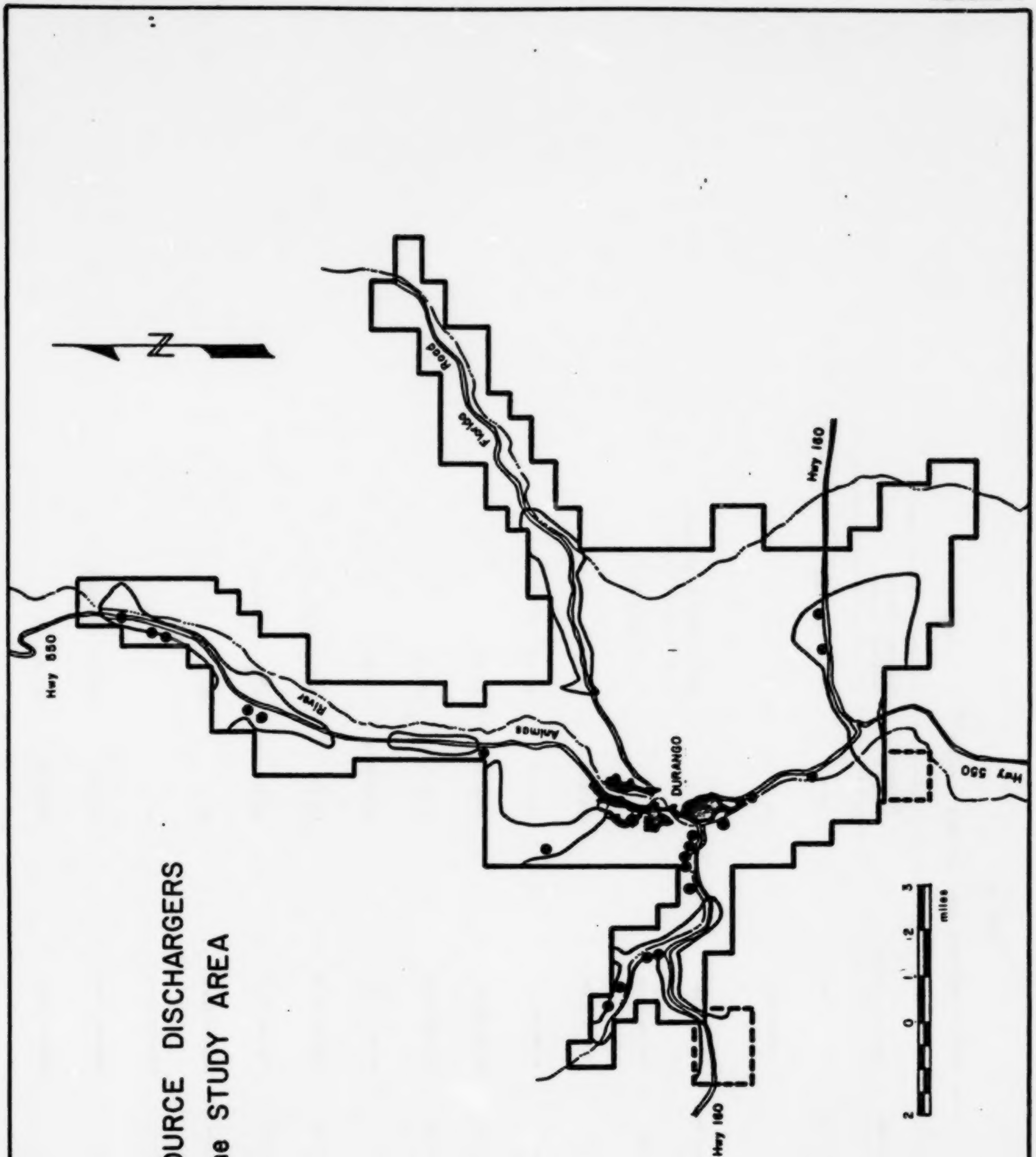
8. Turbidity, nitrate, and nitrite concentrations are lower in the Florida River than in the Animas River, but ammonia concentrations tend to be slightly higher.

The limited data on the Florida River indicate that temperature, alkalinity, sodium, chlorides, and possibly ammonia may be contributing to water quality problems in the Animas River.

Dischargers

There are 24 potential point source dischargers in the Study Area, (Reference 12). Approximate locations of the discharge points are presented in Figure 8. Discharge rates and treatment types are listed in Table 11. Ten sources discharge directly into the Animas River, nine sources discharge into Lightner Creek, Hermosa Creek has two dischargers, two sources discharge into Wilson Gulch, and one source discharges into Junction Creek.

The largest discharger in the region is the city of Durango municipal treatment facility. Self-reporting data from this treatment facility are available from EPA and the Colorado Department of Health. These data indicate that only small amounts, if any, of oil and grease are present in the effluent. BOD is removed at a high percentage during treatment, and total suspended solids are low. Occasionally pH increases, but it is usually in compliance with standards. Fecal coliform


Hwy 550
River
Animas
Florida Road
DURANGO
Hwy 160
Hwy 160
Hwy 550
N
2
0
1
2
3
miles

POINT SOURCE DISCHARGERS in the STUDY AREA

TABLE II

ANIMAS RIVER DRAINAGE POINT SOURCE DISCHARGE INVENTORY(13)

Facility Name	Type of Treatment	Receiving Stream	Discharge Permit	Discharge Rate or Treatment Capacity
Ponderosa KOA Campground	Extended Aeration Package Plant	Animas River	Applied	10 P.E. (seasonal)
Lonely Trails Trading Post & Restaurant		Animas River	No	
Whispering Pines Trailer Park	Extended Aeration Package Plant	Animas River	No	Approx. 200 P.E. (Discharge to meadow above river)
Bear Hollow Campground	Non-discharging Lagoon	Hermosa Creek		50 P.E. (seasonal)
Hermosa Meadows Camper Park	Non-discharging Lagoon	Hermosa Creek	Applied	100 P.E.
Lone Pine Mobile Home Park	Extended Aeration Package Plant	Animas River	Applied	150 P.E.
Marymac Mobile Home Park	Extended Aeration Package Plant	Animas River	CO-0022799	150 P.E.
Junction Creek Trailer Park	Extended Aeration Package Plant	Junction Creek	CO-022748	50 P.E.
Durango Fish Hatchery	Settling Basin	Animas River	CO-0000281	1.9 MGD
Lightner Creek Safari Camp	Extended Aeration Package Plant	Lightner Creek	Applied	150 P.E. (seasonal)
Ramada Camp Inn	Extended Aeration Package Plant	Lightner Creek	Applied	50 P.E. (seasonal)
Lightner Creek Mobile Home Park	Extended Aeration to Lagoon	Lightner Creek	No	50
Twin Buttes Fish Pond & Hatchery	Settling Ponds	Lightner Creek	No	
Four Winds Motel	3 Septic Tanks with Lagoon	Lightner Creek	Applied	100 P.E. (seasonal)
Perins Peak Mobile Park	Home Made Aeration System	Lightner Creek	CO-0022705	10 P.E.

TABLE II (Continued)

Facility Name	Type of Treatment	Receiving Stream	Discharge Permit	Discharge Rate or Treatment Capacity
Durango Inn	Extended Aeration Package Plant	Lightner Creek	No	Approx. 100 P.E.
Shakey's Pizza Parlor	Extended Aeration to Lagoon	Lightner Creek	No	Approx. 60 P.E.
Cottonwood Camper Park	Extended Aeration Package Plant	Lightner Creek	Applied	100 P.E. (seasonal)
City of Durango	Trickling Filter Plant	Animas River	CO-0024082	16, 000 P.E.
San Juan Lumber Co.	Non-discharging Lagoon	Animas River	Applied	
Basin Packing Company	Aerated Basin to Lagoon	Animas River	No	Approx. 8,000 to 10,000 gpd
Pinon Acres KOA Campground	Lagoon	Wilson Gulch	No	50 P.E. (seasonal)
Grandview Hotel	Extended Aeration Package Plant	Wilson Gulch	No	120 P.E.
Chevron Station & Branding Iron Restaurant	Extended Aeration Package Plant	Animas River		40 P.E.

P.E. = Population Equivalent

concentrations vary considerably, from 1/100 ml to 10,000/100 ml, but are generally moderate to low. The effluent fecal coliform concentration is much lower than that found downstream at station 66. In general, the effluent is of relatively good quality, and probably has no major adverse affects on the Animas River.

The other direct dischargers into the Animas River are considerably smaller than the municipal treatment plant. Waste water quality data from these nine sources are currently not available. It is possible that the combined affect of these nine dischargers is significant.

Data for discharges into Lightner Creek are not available. It was determined in a Colorado Department of Health study (Reference 13) that discharges into Lightner Creek were having negative impacts on this stream's quality. Lightner Creek, in turn, is a probable source of degradation to the Animas River.

Potential point source discharges into Hermosa Creek use non-discharging lagoons for waste treatment; therefore, impacts to this stream from point source discharges are supposed to be eliminated.

State sampling data reveal that the Junction Creek Trailer Park discharges wastewater which is excessively high in fecal coliforms to Junction Creek. The effluent quality recorded from four recent samplings is presented in Table 12. Although the flow from the trailer park is small, the fecal coliform content of the wastewater probably causes degradation of Junction Creek. This degradation may reach the Animas River.

GROUNDWATER QUALITY

The State of Colorado has established standards of quality for groundwater which is to be used as a domestic water supply, (Reference 18). The state recognizes two categories of domestic water supply groundwater: 1) waters which are not specifically classified for domestic use, or which have qualities not considered suitable for domestic use but which may be suitable after special treatment, and 2) uncontaminated groundwater which will meet drinking water regulations without treatment. The state requires all domestic water supplies be disinfected unless a waiver has been obtained.

Drinking water standards of the State of Colorado match those set forth by the Federal Government. The standards relevant to groundwater data for the Study Area are presented in Table 13 (References 19, 20, 21).

Data Sources

Groundwater data of the Study Area is sparse and incomplete. Information sources for groundwater include the United States Geological Survey (USGS), the Colorado Department of Waters Resources, and EPA STORET data.

TABLE 12

JUNCTION CREEK TRAILER PARK

DISCHARGE DATA

DATE MONITORED

	4/27 76	2/16 77	4/12 77	4/19 77	5/4 77	10/18 77	5/24 78	7/18 78	8/3 78	8/8 78	8/24 78	4/10 79
Temperature, °F		38.0	48.0	55.0	53.0	54.0	64.4	73.4	69.8	64.4	64.4	41.0
pH, Units	7.5	7.8				7.1	7.2	6.8	7.4	7.5		8.8
Dissolved Oxygen, mg/l	7.2	7.9	3.6	4.8	3.0	5.1	1.0	3.8	4.9	3.7	5.0	8.4
Chlorine Residual, mg/l	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0
BOD, mg/l	161.0	50.0	97.0	25.0	212.0	15.0	230.0	19.0	28.0	9.0	13.0	18.0
Oil and Grease, mg/l	10.6	<10.0	18.0	0.7	7.1	<10.0	<10.0	<10.0	<10.0	<10.0	<1.0	<10.0
Suspended solids, mg/l	114.0		141.0	120.0	140.0	14.0	51.0	30.0	40.0		45.0	310.0

4,300 39,000 330,000 170,000 430,000 3,100 150,000 2,300,000 110,000 4,000 31,000 230,000

TABLE 13

STANDARDS FOR DOMESTIC GROUNDWATER SUPPLY

Parameter	Limit
Arsenic	0.05 mg/l
Chloride	250 mg/l
Fluoride	1.4-2.4 mg/l*
Iron	0.3 mg/l
Manganese	0.05 mg/l
Nitrate	10 mg/l
pH	509
Phosphate	No recommendation
Selenium	0.01 mg/l

* Limit varies with temperature of water

The USGS data provided a description of the general characteristics of various aquifers and general groundwater availability. No unique groundwater quality data are available from this source (Reference 22).

The Colorado Department of Water Resources data consisted of wells in the Study Area, (Reference 23). Most wells of the area were identified, and data such as well yield, well depth, and water level at the time of drilling were given.

The EPA STORET data were the most useful for groundwater quality evaluation, (Reference 24). Detailed data are presented for twenty-two different wells in the area. These data, however, cannot be considered comprehensive because only one sample was taken at each well, and most of the data is somewhat dated (1974 or 1975). In addition, data are concentrated in specific areas of the Study Area and are sparse to nonexistent in other areas. Florida Mesa contains approximately sixty-three percent of the wells sampled, while the Florida River area and the area immediately east of the city of Durango contain another twenty-two percent. No data are available for the Animas Valley near Hermosa nor for the area along the Animas River south of Durango.

Groundwater Data Evaluation

The EPA STORET data include groundwater quality information for twenty-seven wells in the Study Area. Specifics about each well are presented in Table 14. Well depth and water level at the time of sampling are noted, along with approximate well yield. This latter characteristic is from the Colorado Department of Water Resources data and was not available for every well on the EPA STORET list. The monitored water quality for each well is presented in Table 15.

TABLE 14

STUDY AREA WELL INFORMATION

I.D.	Owner	Yield (GPM	Depth (Ft.)	Water Level (Ft.)	Aquifer
1.	Simon	10	137	99.7	Alluvium
2.	Wuest	-	180	55.85	Animas
3.	Fassett	-	240	46.84	Animas
4.	Colescott	20	90	55	Unknown
5.	Baker	15.0	83	57	Unknown
6.	Craig	5.0	60	51.18	Alluvium
7.	Unknown	-	201	45.42	Unknown
8.	Butler	-	200	38.02	Unknown
9.	Butler	-	300	46.62	Animas
10.	Decker	-	304	100.44	Animas
11.	Belger	4.0	114	30.72	Alluvium
12.	Queen	5.0	234	95	Unknown
13.	Cooper	-	49	37	Alluvium
14.	Barry	-	63	19.72	Unknown
15.	Cudiff	-	31	19.76	Alluvium
16.	Miller	30.0	140	61.61	Animas
17.	MacClean	-	80	-	Animas
18.	Cushing	-	180	-	Animas
19.	Palmer	10	110	95	Unknown
20.	Snider	5.0	105	62.37	Mancos
21.	Connor	10	57	47	Alluvium
22.	Hightower	-	102	19.88	Menefee
23.	Schriner	15	75	38.39	Alluvium
24.	Axtman	5	103	80.75	Mancos
25.	Balliger	-	115	69.73	Morrison
26.	Repert	30	105	69.79	Alluvium
27.	Haja	-	152	84.64	Morrison

TABLE 15

GROUNDWATER QUALITY DATA

	Well Identification[1]					
	1	2	3	4	5	6
Temperature °C	11.5	6.99	10.25	12.00	5.99	4.0
Conductivity, μmhos	459.99	569.99	712.50	649.99	599.99	874.99
Alkalinity mg/l	223.00	293.00	21.90	310.00	285.00	354.00
	231.90	288.6	195.3	274.6	316.69	407.60
Nitrate & Nitrite, mg/l	1.86	9.299	15.5	3.72	8.68	3.10
Ortho Phosphate, mg/l	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Phosphorus, mg/l						
Hardness mg/l	235.0	315.00	285.00	280.00	295.00	464.99
Noncarbonate Hardness, mg/l	44.99	77.99	111.0	0.00	35.00	131.00
Dissolved Calcium, mg/l	78.16	100.20	84.17	92.18	76.15	98.199
Dissolved Magnesium, mg/l	9.73	15.81	18.24	12.16	25.54	53.499
Dissolved Sodium mg/l	12.87	35.63	43.68	33.57	27.13	23.45
SAR	0.40	0.90	1.10	0.87	0.70	0.50
Dissolved Potassium, mg/l	1.17	1.560	0.78	1.17	0.78	1.17
Chloride, mg/l	14.18	33.69	85.09	10.64	24.82	30.139
Sulfate, mg/l	34.1	44.19	51.39	44.67	30.26	134.50
Dissolved Fluoride, mg/l	0.17	0.10	0.44	0.12	0.13	0.13
Dissolved Silica, mg/l						
Dissolved Arsenic, μg/l	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Iron, μg/l	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Manganese, μg/l						
Dissolved Selenium, μg/l	2.00	4.00	160.00	2.00	3.00	9.99
TDS, mg/l	295.00	435.00	455.99	389.00	358.0	612.99
pH, units		7.20	7.599	7.899	7.299	6.99
Boron, μg/l	0.00	0.00	0.00	0.00	0.00	0.00

[1] See Table 14

TABLE 15 (continued)

GROUNDWATER QUALITY DATA

	Well Identification[1]					
	7	8	9	10	11	12
Temperature °C	14.00	12.00	16.00	9.99	9.99	14.5
Conductivity, µmhos	535.0	313.00	849.49	479.99	459.99	649.99
Alkalinity	227.0	133.00	199.00	239.00	228.0	243.00
	277.00	154.00	192.00	291.00	249.00	255.7
Nitrate & Nitrite, mg/l	0.79	0.130	0.25	0.45	1.86	0.62
Ortho Phosphate, mg/l	0.06	0.03	0.02	0.06	0.01	0.00
Dissolved Phosphorus, mg/l	0.02	0.01		0.02		
Hardness	180.00	28.00	30.0	200.0	195.0	59.99
Noncarbonate Hardness, mg/l	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved Calcium, mg/l	59.00	0.699	9.99	62.99	70.14	20.04
Dissolved Magnesium, mg/l	7.8	0.999	1.20	9.99	0.49	2.43
Dissolved Sodium, mg/l	46.00	60.99	167.00	34.00	29.43	128.7
SAR	1.50	5.00	13.00	1.10	1.0	7.23
Dissolved Potassium, mg/l	0.8	0.50	0.30	1.6	0.78	0.78
Chloride, mg/l	21.0	15.00	64.99	12.0	3.55	50.35
Sulfate, mg/l	22.0	58.99	65.99	24.0	38.89	33.61
Dissolved Fluoride, mg/l	0.90	1.60	8.79	0.699	0.23	2.41
Dissolved Silica, mg/l	10.00	2.80		16.0		
Dissolved Arsenic, µg/l	1.00	0.99	7.99		0.00	4.00
Dissolved Iron, µg/l	30.00	99.99	0.00	49.99	0.00	0.00
Dissolved Manganese, µg/l	30.00	20.00		0.00		
Dissolved Selenium, µg/l	3.0	0.00	0.00		0.99	2.00
TDS, mg/l	308.0	178.00	405.99	367.0	293.0	356.0
pH, units	7.8	8.79	9.30	7.49	7.39	8.49
Boron, µg/l	6.00	5.99	0.00		0.00	399.00

[1] See Table 14

TABLE 15 (continued)

GROUNDWATER QUALITY DATA

	Well Identification[1]					
	13	14	15	16	17	18
Temperature °C	7.49	13.0	11.00	5.5	6.0	17.00
Conductivity, µmhos	659.99	618.00	644.99	667.00	470.00	436.00
Alkalinity	278.00	273.00	310.00	353.00	254.00	199.00
	331.29	333.00	324.59	430.00	310.00	243.00
Nitrate & Nitrite, mg/l	9.29	2.60	6.199	0.010	0.67	0.26
Ortho Phosphate, mg/l	0.03	0.18	0.02	0.00	0.00	0.00
Dissolved Phosphorus, mg/l		0.06		0.00	0.00	0.00
Hardness	300.00	270.00	305.00	13.0	50.00	200.0
Noncarbonate Hardness, mg/l	29.00	0.00	0.00	0.00	0.00	0.00
Dissolved Calcium, mg/l	100.2	91.00	108.20	4.3	19.00	64.00
Dissolved Magnesium, mg/l	12.16	10.00	8.51	0.5	0.70	9.10
Dissolved Sodium, mg/l	42.00	22.00	26.90	180.00	120.00	16.00
SAR	1.10	0.60	0.67	22.00	7.40	0.50
Dissolved Potassium, mg/l	1.17	0.80	0.78	0.40	0.50	0.40
Chloride, mg/l	24.82	16.00	14.18	14.00	10.00	9.70
Sulfate, mg/l	56.68	22.00	27.38	33.00	27.00	35.00
Dissolved Fluoride, mg/l	0.18	0.20	0.120	1.200	1.40	0.20
Dissolved Silica, mg/l		18.00		9.50	9.20	10.00
Dissolved Arsenic, µg/l	0.00	1.00	0.00	1.00	2.0	
Dissolved Iron, µg/l	0.00	20.00	0.00	20.00	40.00	30.00
Dissolved Manganese, µg/l		0.00		0.00	0.00	20.00
Dissolved Selenium, µg/l	2.00	1.00	0.999	0.00	0.00	
TDS, mg/l	424.99	356.00	423.99	455.00	344.00	265.00
pH, units	7.09	7.1	6.89	8.0	7.7	7.4
Boron, µg/l	0.00	30.00	0.00			10.00

---

[1] See Table 14

TABLE 15 (continued)

GROUNDWATER QUALITY DATA

	Well Identification[1]				
	19	20	21	22	23
Temperature °C	8.5	10.00	7.00	6.00	8.00
Conductivity μmhos	710.00	2,278.	348.00	1,060	5,630
Alkalinity	280.00	1,030	176.00	437.00	477.00
	341.00	1,250	215.00	533.00	581.00
Nitrate & Nitrite, mb/l	1.10	0.01	0.15	0.280	23.00
Ortho Phosphate, mg/l	0.12	0.12	0.00	0.03	0.670
Dissolved Phosphorus, mg/l	0.04	0.04	0.00	0.010	0.22
Hardness	310.00	48.00	190.00	250.00	2,400
Noncarbonate Hardness, mg/l	32.00	0.00	12.00	0.00	1,900
Dissolved Calcium, mg/l	110.00	9.30	50.00	62.00	600.00
Dissolved magnesium, mg/l	8.90	6.10	10.00	23.00	220.00
Dissolved Sodium, mg/l	44.00	610.00	4.5	200.00	780.00
SAR	1.10	38.00	0.10	5.50	6.9
Dissolved Potassium, mg/l	0.90	2.00	1.14	2.8	11.00
Chloride, mg/l	7.60	130.00	1.8	15.00	1,400
Sulfate, mg/l	91.00	190.00	19.00	220.00	1,400
Dissolved Fluoride, mg/l	0.40	2.80	0.10	0.30	0.30
Dissolved Silica, mg/l	13.00	7.30	6.70	13.00	20.0
Dissolved Arsenic, μg/l	1.00	0.00	1.00	0.00	3.00
Dissolved Iron, μg/l	20.00	40.00	20.00	1,500	60.00
Dissolved Manganese, μg/l	0.00	0.00	0.00	100.00	30.00
Dissolved Selenium, μg/l	1.00	6.00	0.00	1.00	8.00
TDS, mg/l	449.00	1,570	209.00	811.00	4,820
pH, units		8.2	7.30	7.10	7.30
Boron, μg/l					

---

[1] See Table 14

TABLE 15 (continued)

GROUNDWATER QUALITY DATA

	Well Identification[1]			
	24	25	26	27
Temperature °C	0.00	6.00	10.5	8.5
Conductivity μmhos	932.00	370.00	552	550
Alkalinity	508.00	154.00	302	255
	603.00	188.00	368	311
Nitrate & Nitrite, mg/l	0.10	0.140	0.14	0.02
Ortho Phosphate, mg/l	0.03	0.03	0.00	0.15
Dissolved Phosphorus, mg/l	0.01	0.01	0.00	0.05
Hardness	12.00	180.00	320	200
Noncarbonate Hardness, mg/l	0.00	28.00	15.00	0.00
Dissolved Calcium, mg/l	3.30	55.00	79.00	50.00
Dissolved Magnesium, mg/l	1.00	11.00	29.00	18.00
Dissolved Sodium, mg/l	250.00	6.4	13.00	30.00
SAR	31.00	0.2	0.30	0.90
Dissolved Potassium, mg/l	0.60	0.7	3.10	6.6
Chloride, mg/l	20.00	1.8	4.10	5.6
Sulfate, mg/l	34.00	43.00	37.00	15.00
Dissolved Fluoride, mg/l	1.10	0.20	0.10	0.6
Dissolved Silica, mg/l	7.60	5.30	13.00	15.00
Dissolved Arsenic, μg/l	0.00	0.00	1.00	14.00
Dissolved Iron, μg/l	160.00	10.00	20.00	1,800
Dissolved Manganese, μg/l	20.00	0.00	0.00	110.00
Dissolved Selenium, μg/l	0.00	0.00	2.00	0.00
TDS, mg/l	623.00	217.00	360	296
pH, units	9.1	7.3	7.7	
Boron, μg/l	0.8			

---

[1] See Table 14

Possible groundwater contamination from human activity is often indicated by high concentrations of nitrogen oxides (NO_2 and NO_3) and by concentrations of sodium and chloride in excess of those found in the area or in the underlying geologic formations. Violations of standards for any metal could also be an indication of man-induced contamination, particularly if the metal is not native to the area or formation. No concrete conclusions on groundwater in the Study Area can be drawn from this one-sample data, but some generalizations will be made.

Lightner and Junction Creek Areas

Included in these areas are data from four wells: numbers 20, 21, 25, and 27. Review of the data from these wells indicates the following:

1. Nitrate-nitrite concentrations are low for all wells.

2. Well 20 has one of the highest sodium concentrations of any well in the entire Study Area. This might indicate possible contamination. However, the Mancos aquifer from which this well draws its water is typically a sodium bicarbonate type, (Reference 22), so the excess sodium could be from natural sources. The other wells in this area do not draw from the Mancos formation, and have low sodium concentrations.

3. Well 20 has one of the highest chloride concentrations of any well in the entire Study Area. This might indicate possible contamination. Again, the Mancos aquifer is reported to be naturally high in chloride. Further study may be warranted to determine if contamination of the groundwater has actually occurred.

Florida River Area

This section of the Study Area encompasses a small segment of the Florida River and the area immediately east of Durange between the city and the Florida River. Included in this area are six wells: numbers 18, 19, 22, 23, 24 and 26. Review of the data for these wells reveals the following:

1. Well 23 has excessively high concentrations of nitrate-nitrites, salt, and metal parameters. Either this well is located atop a pocket of bad water or it is polluted.

2. Waters from wells 18, 22, 24, and 26 show low nitrate-nitrite concentrations. The nitrate-nitrite concentration of well 19 is somewhat higher, but is not in violation of the Public Health Standard. The higher nitrate-nitrite concentration might be attributable to the well's being rechanged by the Florida River, which has a similar nitrogen content to that of well 19.

3. Wells 18, 19, 24, and 26 show low sodium concentrations. Well 22 shows a higher sodium content, although it is not in excess of the standard. This well is in the Menefee aquifer, which is a sodium bicarbonate type; thus, the water would naturally tend to have a rather high sodium concentration.

4. Wells 18, 19, 22, and 26 show low chloride concentraions.

5. Manganese and iron Public Health Standards are violated in the water of well 22. This is not uncommon for water of the Menefee aquifer.

6. Well 24 water shows a pH slightly in excess of the Public Health Standard.

Florida Mesa Area

This section of the Study Area includes the Florida Mesa south and west of Durango. Included in this section are seventeen wells, numbers 1 through 17. Since the wells in this area are so numerous, they will be divided into three groups for discussion: (1) those wells drawing water from the alluvial aquifer; (2) those wells drawing water from the Animas aquifer; and (3) those wells for which the aquifer source is unknown.

The group of wells drawing water from the alluvial aquifer include wells 1, 6, 11, 13, and 15. The data for these wells indicate the following:

1. Wells 1, 6, and 11 have nitrate-nitrite concentrations that range from 1 mg/l to 4 mg/l. Wells 13 and 15 have higher nitrate-nitrite concentrations of 9 mg/l and 6 mg/l, respectively. None of the concentrations exceeds the Public Health Standards. These nitrogen data indicate a natural nitrogen concentration in the aquifer and perhaps, some contamination.

2. All data indicate that the waters of this group of wells are relatively low in sodium.

3. All data indicate that the waters of this group of wells are low in chloride.

4. Data indicate that no violations of metal standards occurred in the groundwater from this group of wells.

The group of wells drawing water from the Animas aquifer includes wells numbered 2, 3, 9, 10, 16 and 17. The data for these wells reveal the following:

1. Wells, 9, 10, 16, and 17 have low nitrate-nitrite concentrations. Wells 2 and 3, however, have much higher nitrate-nitrite levels, with the concentration of well 3 violating the Public Health Standard. Wells 2 and 3 are near each other, so the high nitrogen levels may be natural to the area, or may be indicative of contamination.

2. Water from wells 2, 3, and 10 show low sodium content. Waters from wells 9, 16, and 17 show much higher sodium concentrations. These wells are not in close proximity to one another, and the Animas formation is not particularly known for high sodium content. These high concentration levels might be an indication of contamination.

3. Chloride is not excessive in the water of any of the wells in this group.

4. The Public Health Standard for selenium is violated in the water of well 2. No other metals standards are violated in waters of any of the other wells in this group.

The group of wells for which the aquifer source is unknown includes wells numbered 4, 5, 7, 8, 12, and 14. Data for these wells show the following:

1. Water from wells in this group generally show a moderate to low nitrate-nitrite concentration except well 5. Well 5 has a high nitrate-nitrite level, but it was still under Public Health Standards.

2. Water from wells in this group show a low sodium concentration except well 12. Well 12 is in close proximity to well 10 and is of similar depth. Well 10 does not have a high sodium concentration; thus, there might be possible contamination.

3. All water from wells in this group show moderate chloride concentrations.

4. No metal standards are violated by the groundwater of wells from this group.

SUPPLEMENTAL WATER QUALITY MONITORING PROGRAM

Because of the incomplete nature of the historical water quality data base for the Durango 201/EIS Study Area, a water quality monitoring program was developed and implemented in June 1979. Because the principal type of wastewater treatment in the Study Area is the conventional septic tank/absorption field, it was determined that the monitoring program would have to occur during the high ground water period in order to identify possible groundwater contamination from these systems. It was recognized that identification of point specific sources of surface pollution would not be possible, due to high runoff.

The monitoring program consisted of six surface water quality stations (three located on the Animas River, and three on the Florida River), nine groundwater stations in the Animas Valley, and three springs on Florida Mesa. These monitoring stations are located in Figure 9.

Temperature, dissolved oxygen (DO), pH, and conductivity were monitored at all surface water quality stations (excluding the springs) at the time of sampling. Water samples were collected and analyzed for the following parameters, using Standard Methods, by Four Corners Environmental Research Institute under the direction of Ms. Doreen Mehs:

- kjeldahl nitrogen
- nitrate nitrogen (NO_3 as N)
- ammonia nitrogen (NH_3 as N)
- hardness
- total dissolved solids (TDS)
- total suspended solids (TSS)
- bio-chemical oxygen demand (BOD)
- chemical oxygen demand (COD)
- orthophosphate
- total phosphate
- alkalinity
- methyl blue active substances (MBAS)
- total coliform
- fecal coliform

Sampling techniques used in this study included a twenty-four hour composite sampling at each of the six surface water stations, one grab sample at each ground water and spring station, and one bacteriological sample at all stations. All but one of the surface water bacteriological samples were reported lost. Additional samples at five surface water stations were collected on July 27, 1979 and analyzed. Therefore, total and fecal coliform data for stations A-1, A-2, A-3, F-2, and F-3 represent this later sampling.

Collection of groundwater samples was facilitated by assistance from the Soil Conservation Service (SCS). Core holes six feet deep were drilled at selected locations in the Animas Valley. These monitoring holes were placed within highway right-of-ways. Permits to drill were received from the Colorado Highway Department in Durango.

Surface Water Monitoring

The Animas and Florida River were sampled on June 16 and 17, 1979. Three stations on each river were selected as monitoring sites. Each station was sampled once every six hours to form a composite sample over a twenty-four-hour period. This procedure was used because many water quality parameters vary within a normal twenty-four-hour day. Grab samples for analyses were collected by standard procedures and placed in noncontaminated containers. Bacterial samples were taken at each station during the second six-hour period. This period was selected because a peak in wastewater discharge generally occurs during the morning hours. If bacteria from septic tanks were entering the stream segments, it is likely that bacterial influence would be most significant during this sampling period.

Field monitored data are presented in Table 16. The chemical and bacterial analyses are presented in Table 17. Values for temperature, DO, and pH are within the standards limitations. Temperatures tend to increase as the waters flow downstream. This is probably a natural occurrence resulting from runoff from agricultural lands and heating by sunlight. In general, the DO values decrease downstream, but no consistency is observed during every sampling period. There is a general rise in pH from the second to the third station on both rivers.

Biochemical oxygen demand increases downstream, from 0.6 to 1.4 mg/l, and from 1.8 to 2.4 mg/l in the Florida and Animas Rivers, respectively. This parameter indicates the amount of oxygen needed to stabilize biodegradable organic materials. An increase in BOD indicates an increased presence of oxygen demanding material, including organic pollutants, in the stream segment.

TABLE 16

FIELD MONITORED PARAMETERS SURFACE WATER QUALITY

Station No.*	Date	Time	Temp. (°C)	(°F)	DO (mg/l)	pH Standard Units	Conductivity (mhos)
F-1	6/16/79	6:50	7.01	(44.62)	9.1	7.91	500
F-2	6/16/79	7:40	7.18	(44.92)	7.9	6.94	3,500
F-3	6/16/79	8:15	7.45	(45.41)	7.80	7.02	1,000
A-1	6/16/79	9:25	4.68	(40.42)	8.50	7.05	500
A-2	6/16/79	9:45	5.63	(42.13)	7.80	7.18	750
A-3	6/16/79	10:45	7.40	(45.32)	6.70	7.45	900
F-1	6/16/79	14:05	7.38	(45.28)	6.55	7.35	1,000
F-2	6/16/79	14:30	9.64	(49.35)	6.67	7.34	1,300
F-3	6/16/79	15:05	10.80	(51.44)	7.87	7.45	1,200
A-1	6/16/79	16:05	9.18	(48.52)	7.60	7.38	100
A-2	6/16/79	16:30	9.78	(49.60)	6.80	7.08	1,100
A-3	6/16/79	16:55	9.40	(48.92)	8.26	7.39	1,200
F-1	6/16/79	19:00	6.98	(44.56)	7.47	7.12	1,000
F-2	6/16/79	19:25	8.07	(46.53)	7.80	6.95	1,100
F-3	6/16/79	19:45	8.76	(47.77)	7.90	6.99	1,200
A-1	6/16/79	20:30	9.59	(49.26)	8.10	7.19	700
A-2	6/16/79	20:45	10.13	(50.23)	7.35	6.66	1,000
A-3	6/16/79	21:25	9.95	(49.91)	7.10	7.11	1,000
F-1	6/16/79	22:15	7.03	(44.65)	8.60	6.40	800
F-2	6/16/79	22.35	7.18	(44.92)	8.00	6.82	900
F-3	6/16/79	23.00	7.44	(45.39)	8.02	7.15	1,000
A-1	6/16/79	23:45	7.37	(45.27)	8.44	6.15	500
A-2	6/17/79	0:05	8.26	(46.87)	7.50	7.34	800
A-3	6/17/79	0:30	10.06	(50.11)	7.10	7.29	900

*Locations of stations are shown on Figure A1.

TABLE 17

RESULTS OF CHEMICAL AND BACTERIAL ANALYSES ON SURFACE WATERS OF THE ANIMAS AND FLORIDA RIVERS

Sample*	NO_3 as N (ppmN)	NH_3 as N (ppmN)	Hardness (mg $CaCO_3$/l)	TDS (mg/l)	TSS (mg/l)	BOD (mg/l)	Kjeldahl Nitrogen (ppmN)	COD (mg/l)	Ortho-phosphate (ppm P)	Total Phospate (ppm P)	Alkalinity mg$CaCO_3$/l to methyl orange	MBAS	Total** Coliform (MPN)	Fecal** Coliform (MPN)	Sample
F-1	0.23	<.01	86	77	17	0.6	1.0	60.6	0.023	0.030	313	≤0.1	<1/100 ml	<2/100 ml	F-1
F-2	0.24	<.01	92	91	13	2.1	0.9	4.8^{xxx}	0.045	0.060	340	≤0.1	8/100 ml	4/100 ml	F-2
F-3	0.20	0.01	98	110	5	1.4	0.5	35.3	0.033	0.083	353	≤0.1	17/100 ml	22/100 ml	F-3
A-1	0.28	<.01	57	100	1	1.8	2.2	28.5	0.045	0.072	154	≤0.1	8/100 ml	2/100 ml	A-1
A-2	0.25	<.01	68	140	<1	1.0	<0.5	33.5	0.065	0.270	205	≤0.1	33/100 ml	7/100 ml	A-2
A-3	0.25	<.01	75	95	33	2.4	1.5	23.1	0.145	0.255	277	≤0.1	70/100 ml	5/100 ml	A-3

* Locations of sample stations are shown in Figure 9

** Data analysis for F-2, F-3, A-1, A-2, and A-3 was performed July 27, 1979.

xxx Not considered valid

Orthophosphate and total phosphate also increase in concentration downstream. The Florida River shows an increase in orthophosphate between stations F-1 and F-2, and a continual downstream increase in total phosphate. The Animas River shows a continual increase of both parameters, with the values at station A-3 three times those at station A-1. Increases in these nutrient parameters indicate a potential increase in algal growth in the waters.

Total dissolved solids continually increase downstream in the Florida River but increase only from station A-1 to station A-2 in the Animas River. Total suspended solids increase substantially from station A-2 to station A-3 in the Animas River. No such increase occurs in the Florida River.

Total and fecal coliform samples for all but station F-1 were collected on July 27, 1979, a period of lower flow than the original monitoring period. This lower flow condition should serve to accentuate any coliform problems which might exist. It can be seen from Table 17 that there is a general trend in both rivers for total and fecal coliform counts to increase downstream. However, the increases are not significant and the values remain well below water quality standards.

Hardness and alkalinity show downstream increases in both rivers, and the other chemical parameters; NO_3 as N, NH_3 as N, COD, Kjeldahl nitrogen, and MBAS generally show decreases downstream.

Groundwater and Spring Water Monitoring

Groundwater was monitored in the Animas River valley and spring water was monitored on Florida Mesa. Grab samples were collected June 16 and 17, 1979. Nine groundwater sites in the Animas River valley and three springs on Florida Mesa were selected as sample locations.

The nine sites in the Animas River valley included three near Hermosa (HER-GW-N, HER-GW-C, HER-GW-S), three near Trimble Lane (TL-GW-N, TL-GW-C, TL-GW-S), and three in the south Animas valley (SA-GW-N, SA-GW-C, SA-GW-S). Station HER-GW-N did not yield a sample due to a lack of water; therefore, only eight samples were collected.

The ground water sites were selected using the following criteria: the locations must be accessible by truck so that SCS drilling equipment could have access; the sites must be located near possible pollution sources, i.e., septic tanks, wastewater lagoons, etc.; and the sites must be located with the direction of groundwater movement known, downstream of potential pollution sources. Accessibility by truck, as well as lack of access to private property, inhibited choices for sample locations. The sites chosen were felt to be adequate but not optimum.

The springs were monitored as possible indicators of subsurface contamination on Florida Mesa because these springs are fed by Florida Mesa ground water.

The results of the analyses of the grab samples are presented in Table 18. Total coliform counts of the ground and spring waters vary from point to point, with the highest count, 490/100 ml, being found in the Animas Valley near Hermosa (HER-GW-C). Two points near Trimble Lane show the next highest counts. The fecal coliform count, which can indicate bacterial contamination from septic tanks, is less than 20/100 ml at all points.

The presence of fecal coliform does indicate that contamination though currently low, is occurring. However, the source may not be specifically identified since fecal coliform contamination may originate from animal concentration areas as well as from domestic wastewater. During the groundwater monitoring very few animals were observed in the areas believed to be above the ground water stream.

TABLE 18

RESULTS OF CHEMICAL AND BACTERIAL ANALYSES ON GROUNDWATER AND SPRING WATER GRAB SAMPLES

Sample*	Depth to water (ft)	NO_3 as N (ppmN)	TDS (mg/l)	TSS (mg/l)	Ortho-phosphate (ppm P)	Total Phosphate (ppm P)	MBAS	Total Coliform (MPN)	Fecal Coliform (MPN)	Sample
FM-GW-1		2.10	420	20	0.023	0.060	≤0.1	17/100 ml	11/100 ml	FM-GW-1
FM-GW-2		1.44	320	<1	0.011	0.030	≤0.1	<20/100ml	<20/100 ml	FM-GW-2
FM-GW-3		0.42	370	6	0.011	0.060	≤0.1	23/100 ml	13/100 ml	FM-GW-3
HER-GW-H**										
HER-GW-C	4.0	0.51	490	23,000	0.206	0.240	≤0.1	490/100 ml	20/100 ml	HER-GW-C
HER-GW-S	1.5	0.33	810	2,200	0.355	0.372	≤0.1	5/100 ml	≤2/100 ml	HER-GW-S
TL-GW-H	1.5	0.39	2,220	33,000	0.250	0.260	≤0.1	140/100 ml	20/100 ml	TL-GW-H
TL-GW-S	3.5	0.26	2,500	25,000	0.473	0.505	≤0.1	170/100 ml	20/100 ml	TL-GW-S
TL-GW-C	2.0	0.23	1,400	78,000	0.415	0.445	≤0.1	2/100 ml	<2/100 ml	TL-GW-C
SA-GW-H	2.0	1.96	470	1,000	0.097	0.114	≤0.1	-	-	SA-GW-H
SA-GW-C	0.67	0.23	500	2,300	0.023	0.093	≤0.1	<2/100 ml	<2/100 ml	SA-GW-C
SA-GW-S	4.0	0.23	470	3,200	0.033	0.083	0.3	<2/100 ml	<2/100 ml	SA-GW-S

The methylene blue active substance test which indicates the presence of foaming agents (such as detergents) is less than or equal to 0.2 for all locations except at SA-GW-S which had a value of 0.3. This is a possible indication of septic tank influence; however, the value is within the possible range of laboratory error.

Values for nutrient parameters, NO_3 as N, orthophosphate, and total phosphate, vary widely among the sampling locations. The spring waters show low orthophosphate and total phosphate values, but relatively high NO_3-N values occur at two locations, FM-GW-1 and FM-GW-2. Samples from the Hermosa area have moderate to low NO_3-N values, but high orthophosphate and total phosphate values. Trimble Lane groundwaters show low NO_3-N values; however the highest orthophosphate and total phosphate values occur in this area. Groundwaters from the south Animas valley locations show low values for all these parameters, except station SA-GW-N, which has a NO_3-N value of 1.96 ppm, the highest of any of the groundwater sampling locations. The wide variation of these parameters among stations could be naturally occurring or could indicate pollution problems.

Total dissolved solids and total suspended solids are shown in the table as having high values. The high values for TSS are probably a result of boring hole cave-ins and/or disturbances of the soils containing the groundwaters and spring waters during sampling. TDS values indicate particularly high dissolved solids near Trimble Lane. This is probably a result of geologic formations influencing quality.

Conclusions

The data from the surface water monitoring program of the Animas and Florida Rivers indicate the following:

1. No EPA or Colorado State water quality standards are violated in this group of data. This is potentially a

consequence of the high runoff flows which provide a greater than normal dilution of pollutants in the rivers.

2. BOD of both rivers increases as the waters flow downstream, indicating degradation is occurring. This may be a function of high volumes of nonpoint source pollutants carried by spring runoff.

3. Orthophosphate and total phosphate generally increase in both rivers as the waters flow downstream, indicating some nutrient loadings.

4. Some increases in TDS and TSS are evident, but are not continuous, downstream along both rivers.

5. Values of other parameters, including nitrogen and MBAS, indicate no particular problems exist for these parameters.

The data pertaining to groundwater and spring water, although not comprehensive, indicate the following:

1. No excessive coliform counts, total or fecal, were found at any sample. Some fecal contamination appears to have occurred but the source is currently unknown.

2. The SA-GW-S site shows the presence of foaming agent, indicating possible influence of septic tanks, but it is not believed to be excessive.

3. Samples showed wide ranges in nutrient concentrations, which could indicate natural variation of these parameters or possible pollution problems in some areas.

POPULATION, SOCIOECONOMIC FACTORS, LAND USE

It is the policy of EPA that population forecasts used for purposes of planning local and regional wastewater facilities be consistent with adopted state forecasts. The state forecasts are required to be consistent with national forecasts by state prepared by the U.S. Department of Commerce, Bureau of Economic Analysis for EPA in 1978.

It is also the policy of EPA that wastewater facilities plans be consistent with local land use plans and policies. Both the requirement of consistency in population forecasts and the requirement of consistency in planning are intended to avoid wasteful expenditures of public funds which might result from oversizing or from construction of wastewater facilities in areas not planned for or suitable for development.

This section presents data on recent and future growth in La Plata County and discusses available population forecasts and the status of local land use planning in order to assure that EPA policies are being observed in those areas in which project funding is being sought.

Existing Conditions

Recent Growth Trends

La Plata County with a 1978 population of over 25,000, has grown steadily during the decade of the 1970's, showing an eight-year population increase of thirty-one percent. Most of this growth took place outside the city of Durango, which grew only nine percent over the same period. (Data are summarized in Table 19). These statistics reflect the number of permanent residents. The overall level of population is higher because of part-time residents; people with summer or winter homes in the area, but primary residences elsewhere, and tourists.

TABLE 19

RECENT POPULATION GROWTH IN LA PLATA COUNTY AND DURANGO

	1970	1978	Growth, 1970 to 1980
La Plata County	19,199	25,101	31%
Durango City	10,333	11,245	9%
Durango as Proportion of La Plata County	54%	45%	-

Source: U.S. Census of Population, 1970, and U.S. Census of Population, 1978 (both taken in April).

Sources of Past Growth

The growth of La Plata County mirrors the rapid growth being experienced throughout the Rocky Mountain states, the nation's fastest growing region. A variety of local factors currently encourage growth in the mountain states. Examples are industrial development in Idaho, energy resources development in Wyoming, and metropolitan growth relating to retirement migration and general economic expansion of the "sun belt" states in Arizona and New Mexico.

Colorado has participated in the growth resulting from each of these factors, and southwestern Colorado (the counties of Archuleta, Dolores, La Plata, Montezuma and San Juan) has been growing at a slightly more rapid rate than the rest of the state (see Table 20).

TABLE 20

RECENT POPULATION GROWTH IN THE STATE OF COLORADO
PLANNING AND MANAGEMENT REGION 9

	1970	1980 (midrange estimate)	Growth, 1970 to 1980
Colorado	2,209,597	2,791,325	26%
Region 9	37,356	50,256	35%
Archuleta County	2,700	3,900	44%
Dolores County	1,600	1,600	0
La Plata County	19,200	28,000	46%
Montezuma County	13,000	15,900	22%
San Juan County	800	900	13%

Detail does not add to total due to independent rounding.
Source: Colorado Division of Plkanning, Department of Local Affairs, Demographic Section: "Population Estimates and Projections," August 1979

Tourism. Regional economic data do not suggest a clear-cut explanation for the area's growth, but certainly tourism is an important factor. In the Durango area in particular, tourism appears to be the principal economic force in the community, with sixty-six percent of jobs (exclusive of agriculture, government and self-employed) in retail and service positions, the key tourist-support sectors, as compared with sixty-eight percent in the State as a whole (U.S. Department of Commerce, Bureau of the Census, 1976). An estimate of overnight tourism during the peak summer months was provided in a 1977 report by Henningson, Durham & Richardson; 5,000 overnighters in Durango.

There are important tourist-oriented activities in the greater Durango area both in summer and winter. The Denver and Rio Grande Western Railway, a narrow-gauge railway between Durango and Silverton, designated a National Historic Landmark, is an important attraction for tourists during the summer. The fact that the excursion requires a full day means that visitors typically stay in Durango area at least one night, thereby supporting a large number of lodging and dining places. The area is close to the Mesa Verde National Park with its ruins of ancient cliff dwellings. Skiing brings many visitors into the area, and there are a number of alpine ski areas readily accessible from Durango: Purgatory, Telluride, Wolf Creek, Hesperus and Stoner. Although many skiers find lodging at the ski areas, others stay in Durango or visit the city while in the area. Hunting, fishing, and boating opportunities abound. Both in winter and in summer, travel packages which include Durango accommodations are offered by a number of tour operators. Table 21 summarizes important visitor statistics.

TABLE 21

REPRESENTATIVE VISITOR STATISTICS

	1970	1978
Denver and Rio Grande Western Railroad Passengers	90,000	120,000
Mesa Verde National Park Visitors	525,000	654,000
Purgatory Ski Area Skier Days	64,000	258,493
La Plata Field Passenger Movements	53,000 (1975)	102,395

Source: Durango Chamber of Commerce: "Economic Trends," 1979

Part-time residents. Local observers indicate that the Durango area is increasingly attracting new part-time residents, largely from other states, who establish second homes in La Plata County. The county's attraction for these out-of-state buyers arises from a combination of factors. Because it is an important tourist area in this section of Colorado, many out-of-state travelers have had an opportunity to visit it. This is less true of some of the more out-of-the-way mountain communities such as Lake City and Silverton. It is unquestionably an area of great scenic and natural beauty, still uncrowded and with clean air and lovely mountain vistas. Agricultural potential and numerous outdoor activities are added attractions. Further, Durango is a town of sufficient size to provide stores, services, medical facilities and educational institutions - important assets particularly for those who plan eventually to retire in the area.

In-migrants. Many local observers comment that Durango has no real economic base. Reportedly individuals move in from out of state without jobs, supporting themselves on savings until they find some way of making a livelihood, which often results in their establishing their own retail or service businesses. For this reason, out-of-town financial assets are commonly reckoned among the principal economic resources of the region. It also seems likely that the proportion of self-employed may be higher in the Durango area than would generally be true elsewhere. This supposition is supported by 1976 data showing that the number of business establishments per 100 residents is about thirty percent higher in La Plata County than in Colorado as a whole.

Growth and the Housing Supply

The influx of new people has probably been an important factor contributing to rapidly increasing housing prices in the area. There is general agreement that local housing prices have risen rapidly and currently well exceed the affordability levels of most local households. This situation explains in part the rapid increase in the number of mobile homes in the county over the last few years (from thirteen percent of housing starts in 1975 to thirity-five percent in 1978 and 1979) (PBR, 1980).

At present, there is generally a low volume of construction activity: few builders operate at a scale in excess of ten single-family units a year. Lack of scale economies combined with conservative lending policies of local financial institutions (which affect both construction companies and individual homebuilders) have certainly been factors in high housing costs. The fact that income levels of Durango's permanent residents are generally lower than in the state as a whole exacerbates the problem of housing affordability. However, in the entire region of which Durango is a part, housing costs are reported to be generally high; La Plata County is not exceptional in this respect. Some local observers believe high housing costs to be a major impediment to in-migration into the region (Four Corners, 1978, p. III-24).

Future Growth

La Plata County and Durango are expected to continue to grow in the future: on that point there is consensus. As to the extent of growth and the importance of the various factors which might cause growth, there is no consensus. The following sections review (1) factors which may influence future growth, (2) growth projections prepared by various agencies and (3) the "best guess" projection recommended for environmental assessment.

Influences on Future Growth

Some of the forces encouraging growth in the recent past will continue to operate in the future, and new forces may also materialize.

Tourism. Tourism in La Plata County is expected to continue to expand in the future, although there are some doubts about the magnitude of the expansion and the extent to which it will generate population growth in Durango and the immediately surrounding area of La Plata County. A major concern at present is the influence of the current recession, but underlying that concern is a recognition of La Plata's character as primarily an auto-oriented tourist area. With ever increasing energy costs, areas like Durango may become relatively less popular tourist destinations in the future. Not enough research on the impact of high energy costs on travel patterns has been done to date to allow any definitive statement on this point, but it does seem likely that the rate of expansion of local tourism will stabilize or drop in coming years, assuming that energy remains in short supply.

Another question is the degree to which tourism will generate growth concentrated in the Durango area. The ski areas to the north, Purgatory and Tamarron, are developing residential concentrations of their own which may well result in less Durango-area growth. The Purgatory ski area reportedly has approvals for about 1,080 dwelling units, while Tamarron has approvals for about 100 units this year and will probably develop another 300 eventually along with convention and golf facilities (Neal, pers. comm.). These units may well be primarily used as second homes, but such a concentration may shift to the ski areas residential development for employees and other support people and related commercial development as well.

Energy resources development. Various studies have indicated the presence of developable energy supplies in areas around Durango. One study (Four Corners, 1978) maps areas of current and potential oil and gas production, beds of known coal deposits of commercial value and locations of geothermal resources. Much of the Southern Ute Reservation, which occupies an east-west strip in the southernmost part of La Plata County, appears to have developable oil, gas and/or coal resources, and several geothermal sites are located north of Durango.

The role of the proposed Animas-La Plata project in connection with future energy resources development in the area has been much debated. Current mining technology tends to be highly water-consumptive, and shipping methods (such as pipelines transporting coal in slurry form) can also use large quantities of water. It may be true that energy resource exploitation in this area will not be possible without a major water project such as Animas-La Plata, although facilitation of coal extraction has not been the major argument in defense of the project.*

However, even if the Animas-La Plata project is implemented and does assist in establishing energy resource activities in the La Plata County, there is some question as to where the growth generated by those activities would concentrate. The Animas-La Plata draft EIS indicates that most growth relating to the construction of the water project would take place in la Plata County (90 percent; see p. C-1 of EIS). But the Farmington area is within easy driving range and, as the major urban concentration in the region, might be a stronger magnet for the 3,700-person influx that has been suggested. Farmington had a 1976 population estimated at 36,000 and it serves a much larger hinterland than does Durango, providing a wider array of goods and services.

---

* As stated in the draft EIS: "The long-term effect of project water would be to fulfill a basic need in accommodating the future growth that is expected to occur in the area irrespective of development of the proposed project" (p. C-1).

On the other hand, Farmington is held up as an example of the environmental problems growth can bring to rural parts of the mountain states. Durango also offers a more physically attractive environment, and housing costs are reported to be no lower in Farmington than in La Plata County. There is evidence that some Farmington workers currently commute to work from the Durango area (Durango Herald, May 27, 1980). So if new employment is created in southern La Plata County - whether in

construction of the Animas-La Plata project or in subsequent energy resources or agricultural development - it is difficult to say how newcomers will judge the relative attractions of the two areas at that time, and the ultimate effects can be expected to remain uncertain well into the 1990's.

Agriculture. There are numerous soil types in southwestern Colorado, of which generally the best for agricultural purposes is found on the mesas, the result of wind deposits over millenia. At present, most cultivation in the region is dryland (primarily dry beans and winter wheat): the four major irrigated crops in the region at present are pasture, hay, small grains and corn silage. With the development of the Animas-la Plata project, about 44,000 acres could be converted from dryland to irrigated agriculture, and increase of over twenty-two percent in irrigated acreage. The 209 Water Quality Management Plan (the source of the preceding description) emphasizes the importance of proper management to prevent excessive erosion and sedimentation where irrigation systems are employed in rolling terrain.

Of the five counties in State Planning Region 9, La Plata has the highest proportion of irrigated agriculture, which is generally associated with higher yields and higher agricultural income. In the most recent year for which data are available - 1974 - the county had about 57,000 acres of irrigated land out of a total of 291,000 acres in farms, which is about twenty percent irrigated. That compares to a Region 9 total outside of La Plata County of seven percent irrigated.

There continues to be active agricultural production in the immediate Durango area in the river bottoms, on the mesas and (grazing) in the uplands. Although agricultural employment has been declining, agricultural income has continued to rise during most of the last decade, and this is consistent with national trends suggestive of ever-increasing productivity of labor in American agriculture. The two trends taken together result in increasing personal income per agricultural worker: about twelve percent per year, for example, between 1970 and 1974 (Four Corners, 1978. based on data in Tables A-9 and A-11).

Most of the region's agricultural production is sold outside the region. It seems likely that continued agricultural intensification, which expansion of irrigated acreage would make possible, could have a growth-inducing effect in such supportive industries as agricultural services, retail and other services. However, as with tourism and energy, the magnitude of the growth is uncertain, and the extent to which newly irrigated lands would contribute to the economy of Durango or of Farmington (or even some of the smaller communities) remains open to question.

Factors discouraging growth. In addition to the high cost of housing in the area which was discussed earlier, several other factors may impede growth in La Plata County. Currently one of the most important is the lack of major transportation links. The closest interstate highway, I-70, lies to the north at a distance of 169 miles. While good quality highways do traverse the county, they are not limited access and movement can be interrupted regularly during the winter months. The county has no rail freight service. Finally, because it does not lie on a major transportation route connecting larger metropolitan areas, transportation of goods in and out of Durango tends to be expensive, contributing to high local costs of various goods and operating as a disincentive for all but local-resource-based industries to locate in the area.

A more long term consideration is the water supply. With the development of the Dolores and the Animas-La Plata projects the five-county region will have reached its maximum water development potential (Four Corners, 1978). At that point, further development of urban, industrial or extractive uses could be accomplished only be reductions in agricultural water use through purchase of senior water rights.

Growth Projections

As the preceding description indicates, future growth in La Plata County may arise from a variety of sources, but it is difficult to forecast that growth accurately due to uncertainty as to the timing and magnitude of external forces that will help shape the future of the region - the supply of and the demand for energy resources being perhaps the most important example.

Given this uncertainty, it is not surprising that various estimates of the area's future population should diverge widely. Table 22 presents a series of such projections, which range from a year 2000 county population of 28,000 to almost twice that level. Annual growth rates associated with the projections range from 0.5 percent to 3.6 percent.

Among the projections given are two versions of "existing trends" which are simple extrapolations of historical population statistics. If only the decade of the 1970's is considered, then a growth rate of 3.4 percent describes recent trends; if one were to go back to 1950, a growth rate of 1.9 percent applies. As a rule of thumb, economists

TABLE 22

LA PLATA COUNTY POPULATION PROJECTIONS - YEAR 2000

Source	Resident Population		Year 2000 Estimate Based on Projected Growth Rate	Projected Growth Rate	Comments
	1980	2000			
OBERS, 1972 (U.S. Water Resources Council)	N.T.	N.T.	28,000	0.5%	Annual growth date for Upper San Juan Water Resources Sub-area* is one-half percent over 1980-2000 period, which would result in a year 2000 county population of 28,000. Projections based on economic modeling.
Existing Trends I	26,056	37,850	37,850	1.9%	Based on 1950-1978 county growth rates
Animas-La Plata EIS (U.S. Water and Power Resources Service)	29,084	46,750	46,750	2.4%	Projections use 1970-76 statistical data as the baseline in applying the Bureau of Reclamation Economic Assessment Model
State of Colorado, Divn. of Planning	28,000	53,800	53,800	3.3%	Projections based on economic modeling
Existing Trends II	26,056	50,850	50,850	3.4%	Based on 1970-1978 county growth rate
208 Plan (Colorado Dept. Local Affairs)	N.T.	N.T.	54,650	3.6%	Annual growth rate for Bayfield, Durango, Ignacio and Purgatory analysis areas is 3.6 % over 1980-2000 period, which would result in a year 2000 county population of 54,650. Projections based on economic modeling

N.T. = not tabulated.

preparing projections generally look back for as many years as they plan to project forward. But that is only one of several considerations in population forecasting. Another critical consideration is the extent to which the past is judged to be similar to the likely future in terms of the factors influencing population growth.

The difficulty in the case of Durango is that the similarity of the recent past to the likely future is very hard to foretell. As a result, while certain projections can be set aside as extremely unlikely, the range of potentially realizable levels of growth is a fairly broad one, with plausible annual growth rates probably lying in the 2.0 percent to just over 3.0 percent range.

The very low OBERS rate can be set aside; the Bureau of Economic Analysis (the Department of Commerce agency that prepares the OBERS series) recognizes that the 1972 OBERS projections underestimated the importance of factors encouraging growth in the Mountain, Pacific and Southwest states. Another projection that be set aside (it is not presented in the table) is that prepared by Henningson, Durham & Richardson (HDR, 1977) for the Durango area (3.8 percent) because it was based on an erroneous calculation of the annual growth rate over the 75-year period from 1900 to 1975 of 3.5 percent; in fact, the annual rate over that period was 1.77 percent (see the HDR report, p. IV-2).

Each of the other approaches can make certain claims to validity. While an exhaustive review of the projection methodology in each case might shed some light on forecasting problems, the fundamental difficulty - and this is not uncommon - lies in determining what external factors will influence local growth, and how much. Recognizing that this is a question that, in fairly remote rural areas such as southwestern Colorado, is always going to defy the best attempts at accurate response; it is suggested that a rate of 2.7 percent be accepted as a "guesstimate;" this rate would result in a year 2000 population of 44,350 which lies midway between the lower and higher existing trends projections and not far below the projection the Bureau of Reclamation prepared for the Animas-La Plata project.

This level seems plausible considering the presence of impediments as well as stimli to growth, and it is more consistent with recent experience than are the results of the two State economic models cited.

Accuracy of Projections

As noted in the preceding section, the projected growth rate for la Plata is based in part on the assumption that the future will be similar to the past in terms of the factors influencing population growth. While this assumption does not necessarily require that the next twenty years be a carbon copy of the past twenty to make the projection valid, it does mean that significant changes in economic and demographic conditions and trends as well as in technology could change the way people live and, as a result, their likelihood of visiting or moving to La Plata County.

Some of the national trends that have been observed and have affected growth in the county during the past decade, for example, may either accelerate or decline. The 1970's saw a marked increase in personal real income (that is, incomes grew faster than inflation) and consequently in people's tendencies to travel and to acquire second homes. For the first time in U.S. history, rural (nonmetropolitan) areas experienced greater population growth than metropolitan areas. Longer life expectancies resulted in a larger population aged sixty-five years or older, and the greater number of retired people moved to the nation's sun belt.

The economic conditions of mid-1979 through mid-1980 call into question the probability that these trends will be sustained. Rising gasoline prices have inhibited the ability to travel; high inflation rates have reduced real income growth; higher mortgage interest rates have both slowed housing production and eroded many people's abilities to purchase (and to sell) existing housing, which has in turn decreased geographic mobility. These conditions may be a natural part of the economic cycle or they may signal an end to or the beginning of a departure (of indeterminate length) from the cycle. Their influence on county growth will become apparent only with time.

Changes in local conditions, too, may affect the rate of growth in La Plata County. For instance, construction of the Animas-La Plata project would bring a temporary influx of population during the construction period. It is not known whether these workers would attempt to establish permanent residence in the area, nor is it known what the long-term employment and population effects of the project - which depend on the ultimate use of the water - would be.

Similarly, some recent growth has been attributable to the development of ski areas in the northern part of the county. While development of those areas is not yet complete and is expected to continue for several years, it is not expected to continue to be a source of growth through the end of the century. It is not known whether ski-related development will be replaced with another type of activity that continues to generate growth in the county.

Finally, many county residents find jobs by opening small businesses. At some point, the local market will become saturated and this source of economic development will not longer be available. The resulting lack of new jobs may have an inhibiting effect on population growth not experienced in the past.

Location Of Growth Within La Plata County

The presence of 44,350 residents of La Plata County in the year 2000 would mean an increase of about 19,000 over the 25,231 residents counted in the 1978 Dress Rehearsal Census. These new residents will most likely choose where they live in the county based on a number of factors, including where their jobs are (if they are employed when they move to the area), where land is available, and the price of that land relative to prices in other areas, the perceived advantages and disadvantages of various areas in terms of their own goals for living in the county, and possibly some other factors.

Land availability is a key influence in La Plata County. Much of the land is owned or administered by public agencies including the U.S. Forest Service, the Bureau of Land Management and the State of Colorado; additional lands belong to the Southern Ute Indians. Approximately forty percent of the county, or about 432,000 acres, is in private ownership (Four Corners, 1978, p. II-8). This land is generally located in an east-west band in the northern two-thirds of the southern half of the county.

Some of the private land, while available for ownership, is unsuited to development because of physical constraints. For example, the flood plain of the Animas River covers about one-third of the Animas Valley north of Durango. Another problem is steep slopes, which may have unstable soils or other geologic problems. A third problem is water availability in some watersheds; groundwater tables are very low in some places, making it difficult or expensive to drill successful wells, and in other places there is not enough water to meet all the demand for it. In the latter cases, senior (or preexisting) water rights must be purchased by new development for that development to go ahead.

The relative prices of land in various areas will also play a part in determining where people live within the private ownership aras. Table 23 summarizes land prices in the six 201/EIS study areas as one May 1980. To some extent, price differences reflect the presence or absence of other advantageous features; for example, Durango West, with lots priced at $12,000, has paved streets with curbs and gutters, central water and central sewage treatment.

TABLE 23

COMPARATIVE SAMPLE LAND PRICES IN THE 201/EIS STUDY AREAS

Area	Price		Average Lot/Parcel Size
	Per Acre	Per Lot	
1. Hermosa	\$12,000-14,000		0.5 to 6 acres
		\$8,000-10,000	0.5 acre
	\$ 8,000		23 acres (1 parcel)
2. Junction Creek	\$2,000-2,500		0.5 to 2 acres
3, Lightner Creek	(too few sales to generalize)		
Durango West		\$12,000	0.4 acre
4. Grandview-Loma Linda	\$3,500[a]		unknown
5. Florida Road	\$5,000-6,000		unknown
		\$10,000[b]	3 acres
6. West Animas	\$6,000-7,000		unknown

[a] Close to Route 160 or other paved road.

[b] Very hilly terrain.

Source: Clayton Ebel, La Plata County Assessor, personal communication.

The availability of land for private ownership establishes a geographic limit to the locations of future residential development, and the relative prices for land begin to suggest the potential attractiveness and affordability of various areas within that geographic limit. Other factors that provide indications of potential future growth patterns are the past growth patterns, whether an area's current population is full-time or seasonal, the nature of current development, the availability of water and other services, and local attitudes toward growth.

Another factor is the regulation of land used contained in the Land and Resource Management Plan (LRMP) and the Comprehensive Plan for La Plata County. The Comprehensive Plan is still in preparation, but "desired growth plans" have already been adopted for two of the six planning sectors in the county and a desired growth plan for a third sector is currently being developed. These desired growth plans are mandated for review every year; thus, while they do define the current development guidelines, those guidelines cannot be regarded as unalterable. Further, land use planning is a controversial endeavor in La Plata County and under attack from two directions this year: (1) the LRMP, which sets forth policies and performance standards for development, is the subject of a number of lawsuits and (2) two candidates for County Commissioner have expressed anti-land-regulation commitments, and if elected are considered likely to repeal all county land use regulations. Therefore, while land use planning factors are described for each area, they should be viewed in perspective. Factors influencing growth in each of the 201/EIS Study Areas are discussed below.

Area 1: Hermosa

The Hermosa Study Area is located north of Durango along Highway 550. It is generaly bounded on the east by the Animas River, on the north by Baker's Bridge, on the west by Hermosa Cliffs and on the south by the leveling off of the valley that occurs just south of Trimble Lane. Its focal point is Hermosa, a population center approximately nine miles north of Durango.

The Hermosa Study Area is divided into two subareas: Subarea 1a encompasses the southern portion, extending about one-quarter mile north of the Hermosa center. Subarea 1b covers the remainder of the area, extending north to Baker's Bridge. Subara 1a includes about 2,400 acres; Subarea 1b includes about 1,800 acres.

Current Level of Development

The current population of the Hermosa area is about 1,700.* This population is considered likely to be primarily full-time residents.**

Residential development in the Hermosa area includes approximately 665 living units. Of those units, about 255 are single-family residences, about 340 are mobile homes and about 70 are condominiums or other multiple family structures (such as duplexes and four-plexes). Subarea 1a contains about 465 of these units (149 single-family residences and 316 commercial mobile homes), for an average density of one unit per five acres. Subarea 1b contains the remaining 200 units, for an average density of about one unit per nine acres.

Approximately 61 of the living units in the Hermosa area (all units outside of mobile home parks) have been added since 1977, as shown in Table 24. There are about 100 remaining parcels in the area ith no structures on them, but this figure does not reveal how many of those parcels are buildable, how many are owned by people already living in the area or whether there are other constraints on their development. (It is also not known how many could be subdivided and into how many lots.)

---

*Based on dwelling unit count and population estimate in Hermosa Sanitation District report (Allen, 1980). Household size derived from those figures was also applied to approximately 200 living units in Area 1b.

**Clayton Ebel, La Plata County Assessor, personal communication to Gruen-Gruen + Associates, May 29, 1980.

TABLE 24

RECENT RESIDENTIAL CONSTRUCTION IN HERMOSA STUDY AREA

Year	Single-family Units	Mobile Homes on Lots	Condominiums	Total
1977	12	0	0	12
1978	31	0	0	31
1979	4	7	7[b]	18
1980[a]	0	0	0	0
Total	47	7	7	61

a January 1 through May 27, 1980.

b Included on one building permit.

Source: La Plata County Building Inspector's records.

Influences on Future Development

The future development of the Hermosa area will be affected by the factors described below.

Physical constraints. Both the Animas River flood plain and the steep slopes of Hermosa Cliffs limit the amount of developable land. The flood plain covers about one-third of the valley, with its western limit roughly halfway between the river and the highway (U.S. 550) north of Hermosa center and virtually bordering the Denver & Rio Grande Railroad tracks in the vicinity of Trimble Lane. The cliffs pose a slope and geologic hazard along the western boundary of Subarea 1b.

Land ownership. There are 386 parcels of land in the study area. According to records in the La Plata County assessor's office, none of them are owned by out-of-state-residents.

Land use planning. The recommended desired growth plan for Sector 3 of La Plata County, which includes the Hermosa area, shows an urban core at Hermosa center, with residential development at densities ranging from one living unit per acre to one unit per forty acres through the remainder of the valley. Because the land use planning process and the current land use regulations are under fire at this time, it is not certain whether they will be operative in the future. Even if they are set aside, however, the active opposition of Animas Valley and Hermosa residents to increased density in the area may have some effect of limiting the amount of future development.

Proposed major developments. There are currently several large developments planned or approved for the Hermosa area, some of which have already been started. At full development, they would include approximately 600 dwelling units, as shown in Table 25.

TABLE 25

PROPOSED MAJOR DEVELOPMENTS; HERMOSA STUDY AREA

Name	Number of Units
Blue Sky	200
James Ranch	288[a]
Hermosa Townhouses	110
Total	598

a. About 50 units have been completed.

Source: Interviews with local sources.

Infrastructure. "Infrastructure" refers to the presence of water, sewers and sewage treatment facilities, paved roads and other services to property. Water in the Hermosa area is obtained from the Animas Water Company or from on-site private wells, and is readily available. There are no sewers; sewage is treated either in private septic tanks or in private treatment plants, called "package plants" (for major subdivisions and mobile home parks).* There is currently a ban on new permits for package plants that would discharge to the Animas River, which would restrict future development to that which could have septic tanks (that is, development on lots of at least three acres.** A proposal to form a Hermosa Sanitation District encompassing Subarea 1a, which would have constructed and operated a local treatment plant in the vicinity of Trimble Lane, was defeated in an election held June 10, 1980. Major roads in the area - including the new and old highways, East Animas Road and Trimble Lane - are paved, but many of the local streets are not.

Local attitudes. Area residents who attended the 201 study public meeting expressed concern about and opposition to continued growth in the Animas Valley. Some, however, said they thought it was inevitable and pointed out that much growth had already occurred.

Summary. Approved plans for major developments could allow the population of the Hermosa study area to double. Local attitudes, recent development and land prices all indicate that the area is an attractive one, but major new developments may be inhibited by the restriction on new discharge permits.

---

*San Juan Health Basin regulations prohibit septic tanks on lots smaller than three acres which were platted after 1972 and on lots smaller than one acre platted before 1972.

**Lloyd Hess, Region 9, Other sources have questioned the effectiveness of this restriction.

Area 2: Junction Creek

The Junction Creek study area covers approximately 2,400 acres located north and slightly west of the City of Durango. Central features of the study area are Junction Creek Road and Chapman Lake. Animas City Mountain rises on the east side of the area, and the San Juan National Forest forms the northern boundary.

Current Level of Development

The current population of the Junction Creek study area is estimated to be about 250 people, almost all of whom are full-time residents. According to the draft Facilities Plan, the area contains 40 single-family homes and 38 mobile homes, for a total of 78 living units. Average density in the developed portions of the area is estimated to be one living unit per 2.7 acres (Allen, 1980).

Building permits were issued for nine living units - all single-family homes - between 1977 and May 1980. Three of the permits were issued in 1978 and six were issued in 1979. There are an estimated 420 undeveloped parcels of land in the area.

Influences on Future Development

The level of future development in the Junction Creek study area will be affected primarily by physical constraints, availability of infrastructure and community attitudes toward growth.

Physical constraints. There are slope and hazard constraints on the west and north edges of the study area and in the northwestern part of the area. In the west and northwest, steep slopes occur west of Junction Creek as the land rises sharply from elevations of about 6,700 feet to 7,500 feet and above. In the northeast, the northern slope of Animas City Mountain descends abruptly toward the valley. Another physical constraint is Chapman Lake, which fills with snowmelt early in the year and dries out during the spring and summer.

Land ownership. There are currently about 535 recorded parcels of land in the Junction Creek study area. About 35 of these parcels are owned by out-of-state residents. It is not known how many of these parcels are undeveloped. To the extent that they are, their development into full-time residences is likely not imminent, because they are generally held for investment or for retirement use.

Land use planning. The Junction Creek study area is located in planning Sector 1 of La Plata County. The desired growth plan for the county, which has been adopted, allows residential development in the valley portions of the area at maximum density of one unit per 10 acres.

Proposed major developments. Two major residential subdivisions have been approved in the Juntion Creek area. The Jacob's Cliffs project will contain about 180 lots at full development (only phase one, with 34 lots, is currently platted) and the Durango Estates project will contain about 400 lots (237 are currently platted). Both projects are a number of years old and have seen little or no activity. One problem for Durango Estates has been the lack of an access road, but that problem is reportedly being corrected at the present time (Yates, pers. comm.). In addition to these two subdivisions, there is a smaller project in the area: Sailing Hawks, with 16 recorded lots. These projects are shown in Table 26. Falls Creek Ranch, a planned unit development with 94 lots, lies outside the study area to the north and east.

TABLE 26

MAJOR DEVELOPMENTS IN THE JUNCTION CREEK STUDY AREA

	Number of Units	
Name	Currently Platted	Ultimate
Durango Estates	237	407
Jacob's Cliffs	34	180
Sailing Hawks	16	16
Total	287	503

Source: La Plata County Assessor and interviews with local sources

In addition to the projects that have already been approved, several more are under discussion. The owners of Durango Estates are beginning to discuss adding about 100 condominiums to the existing plan. Other condominiums are under discussion in the vicinity of Chapman Lake. In addition, between 200 and 300 acres of land have been offered for sale by the Utah Electric Company, and this land oould be developed if other conditions permit (Yates, pers. comm.).

Infrastructure. The Junction Creek area does have infrastructure problems. Water availability is perhaps the most serious: lots platted before 1972 have rights to household use (no exterior use, such as for lawns, car washing or animals is permitted) and lots platted since 1972 must purchase senior rights.

Wastewater treatment is provided by private septic tanks except at the mobile home park, which has a package plant. Jacob's Cliffs has an implied consent agreement to connect to the city's sewer line, but the existing line cannot accommodate any flow beyond the amound added by that project.

The only paved road in the area is Junction Creek Road, which is also the only access road to the area. Turtle Creek Road, which provides access from Junction Creek Road to Falls Creek Ranch, is graded but not paved.

Local attitudes. Based on the questions and comments raised at the 201 Study public meeting for Junction Creek, residents of that area are generally opposed to growth and particularly to increased density there. In general, speakers said that they had moved to Junction Creek to get away from the city and did not want the city to follow them. An exception to this overall feeling was expressed by the owners of Sailing Hawks subdivision.

Summary. The presence of large approved subdivisions creates potential for significant additional residential development in the Junction Creek area, but the historic lack of activity in those subdivisions, infrastructure problems and local attitudes suggest that ultimate development will fall short of the amount implied by the approved plans.

Area 3: Lightner Creek and Durango West

Study Area 3 encompasses the two major existing areas of development west of the city of Durango: Lightner Creek and Durango West. The Lightner Creek subarea includes the land on both sides of U.S. Highway 160 west of Durango to the junction with County Road 207 and the land on both sides of County Road 207 to the end of existing development. The Durango West subarea includes the land on both sides of U.S. Highway 160 west of the junction to the western edge of the Durango West development.

Current Level of Development

The Lightner Creek-Durango West area has a current probable population of about 960 people, most of whom are full-time residents. There are an estimated 210 single-family homes and about 40 mobile homes in the area (Allen, 1980), for a total of 250 living units. About 100 of these units are located in Durango West. The density of development in the Lightner Creek subarea is highly varied; in the developed portion of the Durango West subarea, it averages about two living units per acre.

Building permits have been issued for 53 residential units in Area 3 since 1977, as shown in Table 27. There are approximately 135 platted parcels in the area that currently have no structures on them.

Influences on Future Development

Future development in the Lightner Creek subarea will be limited by the availability of undeveloped land and in both subareas by physical constraints.

TABLE 27

BUILDING PERMITS ISSUED IN LIGHTNER CREEK-DURANGO WEST STUDY AREA, 1977-1980

	Number of Permits		
Year	Single-family Residences	Mobile Homes on Lots	Total
1977	0	0	0
1978	0	42	42
1979	11	0	11
1980[a]	0	0	0
Total	11	42	53

a January 1 through May 27, 1980.

Source: La Plata County Building Department.

Physical constraints. Developable land in both portions of Study Area 3 is limited by the steep slopes on both sides of U.S. Highway 160 and County Road 207 (except in the Durango West subdivision itself). A further limitation in the Lightner Creek area is the flood plain of the creek, even though this drainage was not included in the Flood Hazards Report prepared by the u.S. Army Corps of Engineers (Allen, 1980). Therefore, according to the draft Facilities Plan, the usable land in each area is confined to "a very small strip up each valley that is out of the active flood plain and below the surrounding cliffs"

Land ownership. The Lightner Creek-Durango West study area contains approximately 250 recorded parcels of land. Of those parcels, 47 are owned by ont-of-state residents. many of the out-of-state ownerships are of lots in the Durango West subdivisions. It is not known what plans those owners may have for development.

Land use planning. The La Plata County desired growth plan for Sector 1 designates residential development in the Lightner Creek area at densities of one living unit per three acres along Highway 160 (between Durango and the Wildcat Canyon cutoff), one living unit per six acres further west along Highway 160 (between the Wildcat Canyon and Lightner Valley cutoffs) and one living unit per 10 acres further into the valley along County Road 207.

The sector plan shows part of Durango West as a growth center, defined as "an established center that contains urban densities and uses." The area around the growth centr is planned for densities categorized as growth ring (future development area for urban densities and uses), growth fan (one living unit per three acres) and highway rural (one living unit per six acres). The latter category includes only a small amount of land within the study area, south of the major areas designated for denser development on the south side of U.S. Highway 160

Proposed major developments. The major new development in Study Area 3 will be located in the Durango West subarea. Current approved plans call for a total of 800 to 900 living units north of U.S. Highway 160 and an additional 400 units south of the highway. (These 400 units include the 100 units already present.) There would also be a commercial center south of the highway. The Lightner Creek subarea is considered to be fairly well developed, and no plans for major new projects there are under discussion.

Infrastructure. The presence and condition of infrastructure is of concern primarily in the Durango West subarea, because it is considered the only potential new development location in Study Area 3. Durango

West has central sewer and water systems as well as paved roads with curbs. These features make it perhaps the best-equipped subdivision in the Durango area, and help to explain why the selling prices of lots there are so high ($14,000 for an 18,000 square foot lot; see Table 20 for comparative land prices.)

Local attitudes. People who attended the public meeting for the 201 wastewater facilities planning study area from Area 3 all resided in the Lightner Creek subarea. These residents generally expressed the opinion that growth in the Durango area is inevitable, and might as well be accommodated in the most optimum manner.

Summary. The Durango West area is considered by a number of local sources to be a prime growth area, because there are or will be many lots available, it has good infrastructure and it is relatively close to the city of Durango. Growth in Lightner Creek is likely to occur on a smaller, piece-meal basis if at all because much of the buildable land there is already occupied by some type of development.

Area 4: Grandview-Loma Linda

The Grandview-Loma Linda study area encompasses the major areas of existing development south of Durango, generally along U.S. Highway 160 from around its junction with U.S. Highway 550 to about a mile east of Elmore's Store and the cutoff to the La Plata County Airport (Colorado Route 172). Along Highway 160, it includes the areas of Wilson's Gulch, Grandview, Pinon Acres and Loma Linda. It extends south along Colorado Route 172 to the Falfa area.

Current Level of Development

The current population of the Grandview-Loma Linda area is estimated to be about 1,200 residents (Allen, 1980). These residents live in 272 dwelling units, including 226 single-family homes and 46 mobile homes in commercial parks. The average density of dwelling units varies from one per 1.5 acres west of Elmore's Store to one per 2.2 acres east and south of Elmore's Store. There are also a number of motel units and camper spaces in the area.

Development since 1977, as indicated by building permit activity, has included 22 single-family homes and nine mobile homes on lots. This activity is summarized in Table 28. There are about 170 vacant parcels of land in Area 4.

TABLE 28

RECENT RESIDENTIAL CONSTRUCTION IN GRANDVIEW-LOMA LINDA STUDY AREA

Year	Single Family Units	Mobile Homes on Lots	Total
1977	3	0	3
1978	17	0	17
1979	2	9	11
1980[a]	0	0	0
Total	22	9	31

a. January 1 through May 27, 1980.

Source: La Plata County Building Inspector's records.

Influences on Future Development

The availability of wastewater treatment facilities in Area 4 could be an important influence on future development there, as indicated below.

Physical constraints. The Grandview-Loma Linda study area has the greatest amount of level land of any of the 201/EIS study areas. Slope and hazard development constraints exist only in the western part, (1) on both sides of U.S. Highway 160 in Subarea 4a from the western boundary to the Grandview area and (2) along the west side of County Road 213 throughout Subarea 4b.

There is also a small portion of this area where flood hazards form a physical constraint. It is also located in the western part of the study area, around where U.S. Highway 160 turns eastward from the Animas River. Overall, however, the physical constraint areas cover a small proportion of the Area 4.

Land ownership. Of the 440 parcels of land in the Grandview-Loma Linda area, about 15 are owned by out-of-state residents. As in the other areas, it is not known whether these parcels are already developed.

Land use planning. The adopted desired growth plan for La Plata County Sector 6 shows two types of residential densities in the Grandview-Loma Linda area: "highway rural," with a density of one living unit per six acres, along Highway 160 (Subarea 4a) and "rural residential," with one unit per 10 acres, along County Road 213 (Subarea 4b). Portions of the area not included in either of these two categories are classified as "irrigated," a designation which presumes agricultural use and makes development more difficult.

Proposed major developments. Animas Airpark is the only proposed major new development in the Grandview-Loma Linda study area, with 39 recorded lots. The consensus among local sources is that actual development at the Airpark is still considerably in the future, potentially following construction of a proposed shopping center south of Durango and additional filling in of the industrial park.

Infrastructure. Water is generally available in the Grandview-Loma Linda area, and is provided by private wells. Wastewater treatment is accomplished by private septic tanks or evaporation ponds. There has been some experience with failing septic system leachfields in the area resulting from unfavorable soil conditions. Failed septic systems must be replaced with alternative systems, which can cost about $5,000 and are not guaranteed to work. This problem is perceived to be one reason why the Grandview-Loma Linda area has not grown more rapidly and why land prices there are comparatively low (see Table 23).

Another possible reason for slow growth and low land prices is the lack of paved roads in the area. Only the major thoroughfares - U.S. 160, Colorado 172 and County Road 213 - and a few other streets are paved. Roads in the older subdivisions are generally simply bladed; others are graveled.

Local attitudes. Residents of the Grandview-Loma Linda area who attended the 201 Study public meeting for that area expressed mixed opinions about the future of their area: some thought that growth would be inevitable in the Durango area and that their neighborhood would be the most logical next place for development, while others wanted to avoid growth in the area. Other local sources also expressed mixed views. Some believe it to be a natural growth area, particularly for Animas-La Plata project construction workers if that project goes ahead; others think that the poor soil conditions (for septic systems) and the distance from the city of Durango make the area a less desirable location than Durango West and Florida Road.

Summary. While the Grandview-Loma Linda area has the greatest amount of land suitable for development in terms of topography, absence of steep slopes and flood hazards, it has some disadvantages for development in its soil conditions, lack of paved roads and distance from Durango. Community attitudes toward growth are mixed.

Area 5: Florida Road

The Florida Road study area extends along Florida Road from the Timberline View Estates entrance road a distance of about 4.5 miles, climbing 1,000 feet up the Spring Creek drainage to a natural low saddle and then falling into the Florida River drainage. The study area is divided into two subareas: 5a, which lies to the west of the saddle, and 5b, which lies to the east. Each subarea incompasses roughly half of the 2,500-acre study area.

Current Level of Development

The current population of the Florida Road study area is estimated at 283 people, living in 127 dwelling units. About fifty-six of the dwelling units are located in Subarea 5a and about seventy-one are located in Subarea 5b. Average density throughout the area is estimated at one living unit per twelve acres. Twenty-two of the units in the area have been added since 1977, as indicated in Table 29 . There about ninety vacant recorded parcels of land in the study area.

TABLE 29

RECENT RESIDENTIAL CONSTRUCTION IN FLORIDA AREA

Year	Single Family Units	Mobile Homes on Lots	Total
1977	2	0	2
1978	13	0	13
1979	5	2	7
1980[a]	0	0	0
Total	20	2	22

a. January 1 through May 27, 1980.

Source: La Plata County Building Inspector's records.

Influences on Future Development

The Florida area is considered locally to be a prime location for future development because of its proximity to the city of Durango. That development will be influenced by the following factors.

Physical constraints. Slope and hazard constraints cover much of Subarea 5a, where the land rises steeply on the north side and very steeply on the south side of Florida Road. There are similar conditions on both sides of the road at the eastern edge of Subarea 5b. These constraints leave most of the latter area and less than one quarter of the former suitable for development.

Land ownership. There are approximately 220 recorded parcels of land in the Florida study area. Of those, twenty-eight are owned by out-of-state residents. As in the other areas, it is not known how many of the parcels owned by nonresidents are already developed.

Land use planning. The adopted desired growth plan for Sector 5 indicates decreasingly dense development along Florida Road as it moves east. A small portion of Subarea 5a, at the western boundary, is included in the growth ring that surrounds the city of Durango. While no specific densities are defined in that area, it is characterized as a "future development area for urban uses and densities." The center portion of Subarea 5a is designated on the sector plan as a growth fan, with a maximum density of one living unit per three acres. The eastern part of Subarea 5a and all developable portions of Subarea 5b are designated for highway rural densities of one living unit per six acres.

Proposed major developments. The only major development in the Florida study area is Florida River Estates, a subdivision of 120 lots which lies partly within the area. That subdivision, however, is estimated to be 90 percent built as of early 1980 (Ebel, 1980, pers. comm.). Several other current or proposed projects, located near the study area, are described elsewhere.

Infrastructure. The physical infrastructure of the Florida area is similar to most of the other study areas: the major thoroughfare (Florida Road, in this case) is paved but local streets are generally unpaved; water is provided by wells; wastewater treatment is accomplished by private septic systems. There are a few exceptions where water is provided by central systems and wastewater treatment by package plants.

The water supply in Subarea 5b (the Florida River drainage) is legally constrained: developers must purchase senior water rights in order to provide water to new subdivisions. This constraint is apparently more legal than physical so far, as development in the area does not seem to have been slowed by this requirement (Lyle, 1980, pers. comm.).

The water supply in Subarea 5a is not constrained but does have a taste problem. This problem is considered by some sources to lessen the area's attractiveness for development.

Local attitudes. Only one resident of the Florida study area attended the 201 study public meeting for the area, which suggests that there is not much local interest in a wastewater facilities project there.

Summary. There are approximately ninety vacant parcels of land in the Florida area, but these parcels are not concentrated in any particular location. Thus, any development that occurs will likely occur on an individual basis. The major development that many people foresee in this vicinity will probably be located outside the study area, either to the west (near the Court Club) or to the east, particularly if Edgemont Ranch is developed.

Area 6: West Animas

The West Animas study area is located between the City of Durango and Hermosa west of U.S. Highway 550. Its southern boundary is north of Animas City Mountain; its northern boundary is south of Trimble Lane. The area covers about 170 acres.

Current Level of Development

The population of the West Animas study area is estimated to be 240 persons. There are 124 living units in the area, including seventy single-family residences and 54 mobile homes in commercial parks. Of the existing single family residences, eight have been added in the last two years: four received building permits in 1978 and four more received permits in 1979. There are only seven unbuilt parcels of land in the area.

Influences on Future Development

The West Animas study area is expected to account for relatively little of the growth in the Durango area in the future, for the reasons described below.

Physical constraints. The majority of the West Animas area is subject to constraints on suitability for development. Virtually the entire portion of the study area west of the old highway (U.S. 550) is characterized by steep slopes. The new U.S. Highway 550 alignment serves to some extent as a flood protection dike, but the 100-year flood plain of the Animas River mapped by the U.S. Army Corps of Engineers still covers both the southern and northern portions of the study area that lie east of the old alignment. These conditions leave only the central area between the two roads - the Falls Creek alluvial fan - available for more intensive future development.

Land ownership. There are 114 recorded parcels of land in the West Animas study area. All of them are owned by Colorado residents.

Land use planning. The proposed desired growth plan for the Animas Valley (primarily in planning Sector 3) allows residential development in this area at a density of one living unit per acre. This plan has not yet been adopted, and its timetable for adoption is not known.

Proposed major developments. There is one pending major development in the West Animas study area: Waterfall Village, which is a ninety-unit condominium project. It has been approved by the La Plata County Commissioners, but has been delayed as a result of the ban on new effluent discharge systems ("package plants"). Its ultimate development will depend at least in part on the resolution of water quality problems in the Animas River above the city of Durango's raw water intake point.

Infrastructure. The West Animas study area is supplied with water by the Animas Water Company and, along with the Hermosa area (which is?r supplied by the same company), is considered to have the best current water availability of the study areas. Wastewater treatment is handled primarily by private septic systems, with one package plant at the mobile home park. Additional package plants are currently banned by the San Juan Basin Health Unit because of water quality problems in the Animas River (Hess, pers. comm., 1980). Both major roads in the area - the new and old alignments of U.S. Highway 550 - are paved.

Local attitudes. The residents of the West Animas study area who attended the 201 study public meeting generally expressed opposition to growth and felt that a wastewater facilities project in their area would be premature.

Summary. The lack of suitable land available for development and the opposition of area residents to further development appear to validate the general perception that West Animas will not be a major growth area.

Summary of Study Area Development and Development Conditions

The foregoing analysis of existing development and influences on future development conditions is summarized in Table 30 . The table indicates that the Lightner Creek-Durango West and Florida Study Areas have experienced the greatest relative growth since 1976 and have the greatest proportions of out-of-state land ownerships. Infrastructure conditions and availability vary among the six areas; Lightner Creek is the only area considered to have average conditions in all three infrastructure categories (roads, water and wastewater) while Durango West is the only area considered to have better-than-average conditions for all three.

TABLE 30

SUMMARY OF EXISTING DEVELOPMENT AND DEVELOPMENT CONDITIONS, DURANGO 201 STUDY AREAS

Area	Existing Population	Housing Units	% of Housing Units Built 1977-1980[a]	Number of Vacant Recorded Parcels	% of Out-of-State Owners	Infrastructure Conditions[b]		
						Roads	Water	Waste-water
1. Hermosa	1,700	665	9	100	0	0	+	0
2. Junction Creek	250	78	12	420	7	-	-	0
3. Lightner Creek/	575	150	21	135	19	0	0	0
Durango West	385	100				+	+	+
4. Grandview-Loma Linda	1,200	272	11	170	3	0	0	0
5. Florida	283	127	17	90	13	0	-	0
6. West Animas	240	124	6	7	0	0	+	-

[a] January 1, 1977 through May 27, 1980.

[b] "+" indicates better-than-average conditions or availability;
"0" indicates average conditions or availability;
"-" indicates below average conditions or availability.

Source: Cap Allen, Draft Wastewater Facilities Plan; La Plata County Building Inspector's records; La Plata County Assessor's records; Gruen Gruen + Associates

Other Potential Sites for Development

Future population growth and land development in La Plata County will not be limited to the six study areas defined in the 201 wastewater facilities planning process. Other areas in the Durango vicinity that can expect significant growth are (1) the unincorporated private lands in the county near the city of Durango and (2) the U.S. Highway 550 corridor north of Hermosa to the county line, which includes Purgatory ski resort and several second home developments. The city of Durango itself, as defined by its current corporate boundaries, has few development sites. The towns of Bayfield and Ignacio will also experience some growth, but it is likely to be minor compared to that in the locations around and to the north of Durango, which are discussed in turn below.

Unincorporated Private Lands Near the City of Durango

There are a number of development projects proposed or approved for the unincorporated area around the city of Durango. In large part, it is these lands that are included in the Comprehensive Plan's estimate that 2,800 additional dwelling units will be located in the city by the year 2000.

Perhaps the largest of these projects is the Riverside planned unit development, located immediately northeast of the city of Durango, which has been approved by the La Plata County Commissioners. Development there is scheduled to take place over nine years, and will ultimately include 1,038 living units (227 single-family residences, 360 cluster single-family homes, 136 townhouses and 315 apartments) plus commercial space, open space and a recreation club. The project will have central water and wastewater treatment facilities (eventually expected to be connected to the City of Durango system).

Another major close-in development project is Hillcrest Mesa, located on the mesa east of Durango near the golf course and Fort Lewis

College. Preliminary plans for about 200 living units in this area have been approved; it is not known when plans will be submitted for final approval.

A third development location close to the city is the area along Florida Road west of the 201 study area, in the vicinity of the Court Club. Reports that K-Mart was planning to build a shopping center in that area had a positive effect on land values there, which in turn made feasible the redevelopment of some run-down existing structures. Current development activity in that vicinity includes five condominium/townshouse projects, with an estimated total of 95 living units, in various stages of approval or construction.

Further away from the city, but still relatively close, are several more potential development areas. To the southeast, past the Grandview-Loma Linda study area (about midway between Durango and Bayfield), is an existing subdivision called El Rancho Florida. This subdivision has 134 recorded lots in two subdivisions, but little or no existing construction. A third subdivision in the same project would be located to the east of the existing project and would reportedly contain 250 lots (Yates, 1980, pers. comm.). Other "further away" sites have potential for longer-range development, as they have not yet entered the formal development process and are discussed in the possibility or "the owner wants..." mode. Among these sites are the Edgemont Ranch out Florida Road to the east and approximately 2,000 acres in several ownerships out wildcat Canyon Road to the west, in the same general area as the Rafter J subdivision. The latter sites may have to solve water availability problems before development is feasible.

Areas North of Hermosa

The portions of La Plata County in private ownership that lie north of the Hermosa study area along U.S. Highway 550 have recently experienced rapid development as both recreational and residential areas. The two types of activities are tied in with each other, and many of the residential units are condominiums owned by out-of-state residents for second home use, either in conventional ownerships or in timesharing arrangements.

Several of the existing developments have approved plans for expansion. The two major ones are Purgatory and Tamarron. The Purgatory ski area, twenty six miles north of Durango, reportedly has approvals for 1,080 additional living units. Tamarron, just south of Purgatory, has approval for about 100 units this year (1980) and plans to build up to 300 additional units by 1990 (Neal, pers. comm.).

There also appear to be a number of additional development possibilities along the U.S. 550 corridor. Upwards of 250 acres of land there are either owned by developers or on the market, and could hold up to 200 high density (condominium or cluster) dwelling units (Yates, person. comm.).

It should be remembered that residential development in this area is primarily second home or retirement development. Approximately 530 properties, including roughly 475 condominiums, are owned by out-of-state residents. (These figures do not include residents of other areas of Colorado.) Therefore, while there will be substantial development in this part of the county, only a small portion of it is likely to provide homes for full-time residents.

METEROLOGY AND AIR QUALITY

Meterology

A weather reporting station has been maintained at Durango since 1931 and is the source of information for the meterological characteristics of the area.

The Durango area has a relatively cool climate due to its elevation and its topographic orientation. The annual average daily maximum temperature is 63.3°F and the annual average daily minimum temperature is 29.1°F. Highest average monthly temperatures occur during July and August (average monthly mean about 66°F) and the lowest average monthly temperatures occur in December and January (average monthly mean about 27°F). On an annual average basis, approximately 209 days have minimum temperatures of 32°F or less; only 12 days experience maximum temperatures of 90°F and above. Between 1931 and 1973, temperature extremes ranged from a low of -30°F recorded on January 13, 1963 to a high of 101°F recorded on July 5, 1973.

Snow occurs during every month except for June, July and August. Typically the Durango area receives approximately sixty-three inches per year with the greatest amounts occurring during December, January and February. The average annual precipitation is 18.7 inches which is typical of semi-arid environments. The driest months are June and November and the wettest is August. Afternoon thundershowers during the summer are characteristic of the area. The local topography causes large variations in weather within short distances and occasionally heavy thunderstorms cause damaging localized floods in small watersheds. Precipitation generally increases and temperature decreases within increasing altitude, but these variations are modified by the orientation of mountain slopes to the prevailing air currents and the effect of the topographical features in creating local air movements.

Prevailing winds which are predominately from the west provide cool temperatures during the summer and abundant moisture supplies for snow during the winter. Cold artic air masses flow down from the north beginning in the late fall and continue into the spring.

Air Quality

Only limited quantitative information is available for air quality in the Durango Valley. The only air sampling instrument presently operated in the area is a high volume sampler in downtown Durango. Routine measurements are taken for total suspended solids (TSP), sulfates, and nitrates. These data are summarized in Table 31. Sulfate and nitrate concentrations are below the State mean. However, TSP concentrations are typically near the established standard of 75 micro g/m^3 (annual average). In 1979 annual geometric mean TSP concentrations exceeded the standard, while in the three previous years they were 70, 70 and 71 micro g/m^3 respectively (Haig 1980 pers. comm.). The Colorado Air Pollution Division anticipates continued monitoring of TSP concentrations but not of sulfates and nitrates.

Air quality is generally considered good and there are no current air quality problems except for TSP concentrations. The source(s) of this material is unknown. Smoke from fireplaces and stoves is a possible source of suspended solids. Particulates also may come from mud carried to paved roads in the city during the winter and spring from unpaved county roads and driveways. After drying on the pavement, strong winds suspend the fine particles. Residential wood burning stoves and fireplaces may also contribute to TSP concentrations during the winter months.

TABLE 31

AIR QUALITY DATA FOR DURANGO (micro g/m3)

	Total Suspended Particulates				
	Primary Federal Standard	Secondary Federal Standard	Durango 1977	1978	1979
Annual Geometric Mean	75	60	69.68	70.96	81.44
Annual Arithmetic Mean	-	-	76.00	79.48	86.59
Maximum 24-hour Concentration	260	150	218	340	606

	Nitrate Concentrations		Sulfate Concentrations	
	1978	1979	1978	1979
Mean	1.27	1.08	2.64	2.40
24-hour Maximum Concentration	9.3	4.5	7.2	8.8

REFERENCES

1. Stevens, T.A., P.W. Lipman, W.J. Hail, Fred Barker, and R.G. Luedke, Geologic Map of the Durango Quadrangle, Southwestern Colorado. Department of the Interior, United States Geological Survey. Miscellaneous Investigations Series. Map I-764. Washington, D.C. 1974

2. U.S. Geological Quadrangle Maps with Modifications by Colorado State Geological Survey. Geologic Hazards, Surficial Deposits, and Mineral Resources in La Plata County

3. Soil Conservation Service. Soil Survey of La Plata County. Unpublished.

4. U.S. Army, Corps of Engineers. Flood Plain Information, Animas River and Tributaries, Durango, Colorado. Sacramento, California, June 1974

5. U.S. Army, Corps of Engineers. Flood Hazard Information Animas River and Junction and Dry Gulch Creeks. Sacramento, California, May, 1977

6. U.S. Army, Corps of Engineers. Flood Hazard Information. Animas River and Hermosa Creek, Hermosa, Colorado. Sacramento, California. October 1977

7. Owen, H.E. The Animas - La Plata Vegetative Project. 1975

8. Burdick, Hal. Final Report. Wildlife Inventory. Animas - La Plata Project. Colorado Division of Wildlife. Montrose, Colorado. August 1976

9. Somers, Preston. Final Report Fauna Inventory of the Animas - La Plata Project Area. Fort Lewis College. Durango, Colorado. September 1976

10. Smith, Norwin F. Aquatic Inventory Animas - La Plata project. Final Report. Colorado Division of Wildlife. December 1976

11. State of Colorado. Colorado Water Quality Standards. Environmental Reporter, 726:1001, July 20, 1978

12. Colorado Department of Health. Water Quality Control Division. Water Quality Management Plan for the San Juan River Basin Colorado Segment. Prepared by R. Keith Hook and Associates, Inc. Denver, Colorado, October 1975

13. Colorado Department of Health. Water Quality Control Division. Water Quality Survey of the San Juan Basin. By Mark Wuerthele. Denver, Colorado June 1975

14. American Public Health Association, American Water Work Association, and Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater, Fourteenth Edition. Washington, D.C. 1976

15. U.S. Environmental Protection Agency. Environmental Protection Agency National Interim Primary Drinking Water Regulations. Environmental Reporter, 132:0101, December 24, 1975. 41 Federal Register 28402, July 9, 1976

16. Texas Water Development Board. The Texas Water Plan. Austin, Texas, November 1968

17. U.S. Environmental Protection Agency. Quality Criteria for Water. Washington, D.C., July 1976

18. State of Colorado. Colorado Water Quality Standards. Environmental Reporter, 726:1001, July 20, 1978

19. U.S. Environmental Protection Agency. Quality Criterial for Water. Washington, D.C., July 1976

20. U.S. Environmental Protection Agency. Water Quality Criteria, 1972. Washington, D.C., March 1972

21. U.S. Environmental Protection Agency. Environmental Protection Agency National Interim Primary Drinking Water Regulations. Environmental Reporter, 132:0101, December 24, 1975. 41 Federal Register 28402, July 9, 1976

22. United States Geological Survey. Department of the Interior. Availabilities and Chemical Characteristics of Groundwater in Central La Plata County, Colorado. By Robert E. Brogden and T. F. Giles, 1976

23. Colorado Department of Water Resources. Master List of Wells by Location. Denver, Colorado, December 1978

24. U.S. Environmental Protection Agency. STORET data.

APPENDIX B

ENVIRONMENTAL IMPACTS

ENVIRONMENTAL IMPACTS

Environmental impacts associated with implementation of the proposed alternatives to provide wastewater management to the Study Area are presented in this appendix. Impact discussions are organized according to technical discipline in order to facilitate review and comment by regulatory agencies. The arrangement of technical discipline discussions follows that of Chapter 4 Affected Environment of the Environmental Impact Statement.

TOPOGRAPHY

Project Impacts

The proposed alternatives will have little affect on the topography of the area. However, this feature of the existing environment does influence the suitability of various wastewater alternatives in the Study Areas. Slopes too steep for excavation equipment effectively limit the construction of leach fields for on-site disposal systems. Excessive slope also limits the effectiveness of on-site leach field systems, because adequate percolation from the leach field may not occur. In alternatives recommending sewering, topography becomes a significant factor when collection systems are extended into areas where slope does not permit gravity flow in the sewers. Such areas will require an initial outlay of money and resources for the construction of pump stations, plus a permanent electrical energy demand to move the sewage.

Mitigation Measures

State regulations governing individual sewage disposal systems require a registered sanitarian or a registered professional engineer to determine ground slope suitability during the Health Department's review of the permit application.

To avoid permanent electrical energy requirements to pump sewage uphill, local treatment can be provided in areas to be sewered. The preferred alternatives for both the Hermosa and Loma Linda areas include providing local central treatment rather than pumping sewage uphill to the Durango wastewater treatment facility.

GEOLOGY

Project Impacts

The proposed projects will have few if any identifiable impacts on geology. However, geologic features affect the selection and siting of wastewater treatment alternatives. Shallow bedrock limits the effectiveness of on-site leach field disposal systems due to the difficulty of obtaining adequate percolation from the leach field. Pipeline construction is both more difficult and more expensive in areas of shallow bedrock. Facilities built in the area of geologic hazards or potential geologic hazards may be damaged or destroyed if movement occurs within the area.

Mitigation Measures

Inadequate treatment by leach field systems due to shallow bedrock can be avoided by adequate pre-construction testing to acertain that soils are deep enough to provide suitable treatment. Facilities should not be built in areas determined by the Colorado Geological Survey to have unstable slopes or other geologic hazards.

SOILS

Project Impacts

There are several impacts on soil resources associated with the wastewater treatment alternatives proposed for the Study Area. All alternatives that include construction of new facilities or pipeline installations will result in a temporary displacement of soil until backfilling is complete. Disturbed soil is a visual scar and is susceptible to erosion. All alternatives that include subterranean release of effluents, such as the No Action and Formation of Maintenance District alternatives, will continue to affect the assimilative capacity of the soil mantle. Construction of new wastewater treatment facilities, such as the proposed lagoon systems for the Hermosa, Grandview, and Loma Linda areas, will result in the permanent removal of that soil for other uses.

The most important impacts to soils in the Study Area, however, are the indirect impacts associated with increased growth. Development in some areas, and especially in the Grandview/Loma Linda area, is constrained by a lack of adequate sewage treatment and disposal. Providing sewers and sewage treatment to these areas will remove that constraint and will accommodate new growth. Such growth will require conversion of land to urban uses, with consequent loss of soil resources. The significance of the loss depends on the amount of growth that occurs, the amount of soil involved, the soil's value as a productive resource, the erosion potential of the soil, and other similar factors.

The existing soil conditions impose a number of constraints on the alternatives under consideration. These constraints would not necessarily prevent implementation of any of the alternatives, but they were factors considered in selecting the recommended plans. Recommended percolation rates for absorption beds are five to 60 minutes per inch. Soils in such areas as alluvial deposits have rates faster than that, while such areas as Grandview/Loma Linda generally have much slower rates. These areas are constrained for successful operation of on-site land disposal systems. In other areas, such as along U.S. Highway 160 from Wildcat Canyon to the Lightner Creek Road turnoff, difficult terrain and shallow rocky soils would complicate digging the trench for an interceptor line, and would result in higher-than-normal maintenance costs for the line.

Mitigation Measures

Most of the direct impacts of any alternative can be mitigated by using standard engineering practice to minimize disruption of soil and underlying strata during construction, and by requiring restoration of disturbed surfaces and revegetation where appropriate. Soil losses due to construction of new treatment facilities will be balanced by the reclamation of land currently occupied by existing package plants.

Indirect growth-related impacts can be minimized by strict adherence to the desired growth patterns designated in the La Plata County Comprehensive Plan. Adherence to the plan would channel growth into existing urban areas or their peripheries, and would discourage development in rural areas. New development would thus be directed into areas where the soil resources are already substantially disturbed. Adherence to land use plans and ordinances is a local matter, however, and EPA has limited authority over decisions made at the discretion of local authorities.

WATER RESOURCES - SURFACE WATER HYDROLOGY

Project Impacts

The alternatives proposed for wastewater management would have several affects on surface water hydrology in the Study Area. The various alternatives could potentially influence stream alignment and streambed composition, streamflow volumes, the floodplain, and even portions of the watershed.

Anywhere a proposed pipeline crosses a stream channel, such as the Lightner Creek crossing in the recommended Lightner Creek alternative, the flow characteristics of the waterway at that point will be altered. In addition, materials placed in the channel for pipeline stabilization and erosion protection will permanently alter the stream bed at the crossing site.

Stream flow will be temporarily disrupted during construction activities. However, more permanent alterations in stream flow will result from alternatives involving sewers and remote treatment. In the Hermosa area, the recommended central treatment facility will discharge treated effluent to the Animas River. Although part of this effluent will consist of wastewater currently being discharged to the Animas River by existing package plants which will be replaced, it will also include wastewater that is currently treated by on-site leach field disposal. The Animas River will have a net gain, albeit small, in total streamflow. Discharge from the recommended Grandview lagoon system into Wilson Gulch and thence to the Animas River will also contribute new flow to the river. Wastewater in the Grandview area is currently disposed of primarily by evaporation. A net increase of about 100,000 gallons per day in the Animas River can be expected from this facility. The recommended alternative in the Junction Creek Study Area will result in decreased flows in Junction Creek. The wastewater currently discharged to Junction Creek by the Junction Creek Mobile Home Park will instead be piped to the Durango wastewater treatment facility for ultimate discharge into the Animas River. This option will not result in a change in Animas River flow, however, because Junction Creek is tributary to the Animas River.

Much of the development within the narrow Animas Valley has been on the flood plain. Flood plain development has also occurred along Lightner Creek, Junction Creek, Hermosa Creek, and Spring Creek. Sewers could facilitate further development in these areas unless proper safeguards are instituted. The recommended wastewater treatment facility for the Hermosa area will be located within the 100-year flood boundary, and proposed sewer alignments traverse portions of the 100-year flood plain. Development in flood plains can potentially restrict flood flows, increase water velocity, alter flood plain boundaries and contribute to property losses. Flooding of treatment plants, interceptor sewers, collection lines, and on-site sewage disposal facilities can cause an interruption in treatment of wastewater and create public health hazards. One positive impact of providing sewers in the Hermosa area is the elimination of the Hermosa Meadows package plant which is located in the flood hazard area.

There will also be long-term, indirect effects on surface hydrology. Many of the alternative plans involving sewering could accommodate or even encourage growth in the Study Area. Additional land will be developed as this growth occurs. This development could noticeably affect surface hydrology if it results in substantial watershed modifications.

Surface water hydrology imposes constraints on the alternatives considered for the Study Areas. For example, providing sewers in Lightner Valley from U.S. Highway 160 to Safari Campground was rejected because large portions of the alignment would be in the flood hazard area or 100-year flood plain, and multiple pipeline crossings of Lightner Creek would be required.

Mitigation Measures

In most cases, impacts of the recommended alternatives to stream channels and stream flows will be insignificant due to the short lengths of stream and minor volumes of water involved. These impacts are inherent in the management strategies selected, and little can be done to mitigate them.

To mitigate the possibility that selected alternatives providing sewers will facilitate development in flood hazard and flood plain areas, the EPA has stipulated the following grant conditions:

> 1. The grantee and local jurisdiction shall not accept a sewerage connection to any interceptor funded by this grant, from any residential, commercial or industrial structure receiving a local building permit after the date of this grant, if the structure is located within a designated 100-year flood plain. The grantee and local jurisdictions are permitted to accept a sewerage connection from any residential, commercial or industrial structure located within a designated 100-year flood plain, if the structure is in existence or was issued a local building permit prior to the date of award of this Step 2 grant.

A variance to this condition will be considered by EPA if the grantee submits site-specific documentation (including detailed maps of specific plats recommended for variances) that there is no practicable alternative to development within the 100-year flood plain. A minimum requirement for a variance to be granted is a demonstration that the proposed structure will comply with the flood plain management standards of the National Flood Insurance Program and that the proposed flood plain development will not alter the 100-year flood plain so as to increase the risk of flooding to upstream or downstream property. Under no circumstances will a variance be granted for development to be located in the floodway as defined by the National Flood Insurance Program and identified on HUD Flood Boundary Maps. The grantee should refer to Federal Executive Order 11988 dated May 24, 1977, pertaining to "Flood-plain Management" and EPA's "Statement of Procedure for Flood-plain Management and Wetlands Protection", dated January 5, 1979 (44 CFR 1455).

2. Prior to receiving a Step 3 (construction) grant from EPA for any portion of the approved facility plan, the grantee shall, in cooperation with other local officials and flood plain owners, formulate a plan and implementation schedule for removing relocatable dwellings from the flood hazard area as defined by the Federal Emergency Management Agency and for providing flood proofing to improvements within that portion of the 100-year flood plain that lies outside the flood hazard area.

The first condition is self-explanatory. Adherence to the second condition will include providing protection for the Hermosa wastewater treatment facility against a 100-year flood, and installing pipelines in the flood areas with sufficient depth and over-burden to protect against erosion during possible flood conditions.

Indirect growth-related impacts can be minimized by strict adherence to the desired growth patterns designated in the La Plata County Comprehensive Plan. Adherence to the plan would channel growth into existing urban areas or their peripheries, and would discourage development in areas where the watershed is relatively undisturbed. Adherence to land use plans is a local matter, however, and EPA has limited authority over decisions made at the discretion of local authorities.

WATER RESOURCES - SURFACE WATER QUALITY

Project Impacts

Sewering alternatives that include replacement of inadequately operating wastewater treatment facilities that discharge either directly or indirectly to surface waterways will result in an improvement in surface water quality. Formation of a Maintenance District would also result in improved water quality through better operation and maintenance of existing equipment.

Sewer alternatives that include treating and discharging wastewater that was not formerly discharged either directly or indirectly to surface waterways will result in degradation of surface water quality. For example, little wastewater generated in the Grandview area currently enters surface waterways. The effluent from the recommended discharging lagoon will add new amounts of heavy metals, residual chlorine, and nutrients such as nitrogen and phosphorus to the Animas River. Such effluent components could adversely affect aquatic resources by promoting algal blooms or by causing toxic effects to biota.

Alternatives involving construction activities would result in a temporary increase in siltation due to increased soil erosion.

Mitigation Measures

The most important measure to minimize detrimental effects of constituents of "new" wastewater on surface water quality is to make certain that treatment plants are operating properly at all times. This includes having facilities that are well designed, built, and maintained, and having treatment plant operators who are well trained and highly motivated.

Providing better operation and maintenance of existing equipment and/or replacing failing equipment are mitigation measures for the No Action and Maintenance District alternatives which involve continued reliance on existing wastewater treatment methods.

Using standard engineering practices which minimize disruption of soil and expose it to increased erosion for only a short period of time will minimize siltation of waterways.

WATER RESOURCES - GROUND WATER HYDROLOGY AND QUALITY

Alternatives that provide sewers to areas currently treating wastewater with septic tank-leach field systems or other land disposal methods will tend to decrease ground water resources. Not only will sewers reduce percolation of wastewater into the water table, but infiltration/inflow into the pipes may drain away existing ground water.

Ground water quality will improve or be protected from further degradation by implementation of any alternative except the No Action alternative. Maintenance District alternatives would provide improved maintenance and operation of existing facilities and would also require the upgrading and/or replacement of inadequate treatment systems. Sewering alternatives would eliminate subsurface discharge of effluent. Although subsurface disposal systems usually provide adequate treatment, the effluent will still impact ground water quality because of the nature of that treatment. Most of the treatment will occur in the soil material in and below the leach field component, where organic matter and pathogenic organisms will be physically strained and oxidized. Oxidation will result in organic matter and other compounds such as ammonia being converted to more stable forms that are usually ionic. Some of the ions will be absorbed to soil particles or chemically precipitated as insoluble forms. However, the ability of soil to accomplish this removal is limited and, at some point, there will be a "breakthrough" and most of the ionic matter in the percolating wastewater from that time on will be conveyed into the water table. The removal capacity of the soil would differ considerably among the different ionic species that are present in wastewater. If the hydraulic loading factor is too rapid, the ammonium ion (which is in chemical equilibrium with unionized ammonia) may not be fully oxidized to the stable nitrate ion. In this case, breakthrough can occur and result in ground water contamination by ammonium. The above factors can result in a slow increase in mineral and nutrient concentrations in the ground water, with the rate of increase dictated by the loading component,the size and design of the leach field,the amount of ground water available for dilution, and the rate of movement of ground water through the Study Area. This discussion also applies to land treatment/disposal options as well as to the continued use of individual on-site and multiple-customer disposal systems. Thus, even through the current treatment and disposal methods appear to be adequate in most systems, increases in ground water levels and/or in population density could render existing systems unsuitable.

Mitigation Measures

The direct impacts to ground water hydrology associated with the various alternatives are inherent in the management strategies, and little can be done to alter these impacts. However, these impacts do not appear to be significant due to the relatively small volumes of water involved.

Alternatives involving providing sewers are, in a sense, mitigating measures for the existing ground water quality situation. The water quality impacts of these alternatives are inherent in the management strategies proposed and do not present much opportunity for additional mitigation. For Maintenance District and No Action alternatives, vigilant maintenance of existing facilities, both on-site disposal systems and package plants, to ensure proper operation is the best protection against ground water quality degradation. Ground water quality monitoring programs would provide a check on the operation of subsurface discharging systems under No Action or Maintenance District alternatives. The monitoring would provide a warning if disposal systems were not functioning properly.

BIOLOGICAL RESOURCES - VEGETATION

Project Impacts

The direct effects of any of the alternatives on vegetation are fairly small. Few if any effects would be caused by the No Action or Maintenance District alternatives. Alternatives involving construction would result in a complete loss of vegetation over pipeline alignments and at the sites of new sewage treatment facilities.

Indirect effects to vegetation by alternatives that would accommodate or encourage increased growth (sewering alternatives) could be substantial. Such growth will require conversion of land to urban uses, with consequent loss of vegetation resources. Loss of vegetation on building sites and roadways would be complete; vegetation in adjacent areas would probably be altered from climax native species or agricultural crops to lawns and ornamental species. The significance of this loss depends on the amount of growth that occurs in the Study Area, and the amount of growth that occurs outside of designated high density urban areas. Increased human activity associated with growth may also impact vegetation resources.

Recreational activities such as cross-country motorcycling and four-wheeling can damage or destroy vegetation, while firewood gathering removes both vegetation and nutrients from a site. There is also the potential for increased fire hazard due to increases in human activity.

Mitigation Measures

Vegetation losses along pipeline alignments can be mitigated by disrupting as narrow an area as possible during construction, and by revegetating the area when construction has been completed. Losses of vegetation under new sewage facilities can be mitigated by reclaiming and revegetating land currently under package plants which will be replaced.

Indirect growth-related impacts can be minimized by strict adherence to the desired growth patterns designated in the La Plata County Comprehensive Plan. Adherence to the plan would channel growth into the existing urban areas or their peripheries and would discourage development in rural areas. New development would thus be directed into areas where the vegetation is already substantially disturbed. Adherence to land use plans and ordinances is a local matter, however, and EPA has limited authority over decisions made at the discretion of local authorities.

BIOLOGICAL RESOURCES - WILDLIFE AND SPECIAL STATUS SPECIES

All Special Status species in the Study Area are animals. They include the Federally endangered peregrine falcon, the Federally threatened bald eagle, and possibly the State endangered lynx.

Project Impact

The No Action and Maintenance District alternatives would have few if any direct impacts on wildlife. Alternatives involving construction of new facilities, however, could have potentially significant effects on wildlife in the Study Area. Construction would result in a complete loss of wildlife, primarily small mammals, birds, and herptiles, over pipeline alignments and at the site of new sewage treatment facilities. More important, construction activities through wildlife habitat during critical breeding, calving, or wintering periods could cause severe population declines. The Study Area has a large wintering population of bald eagles that occurs primarily along the Animas River and it tributaries (Figure 4.17 in the EIS). Disturbances such as construction along these corridors could cause the eagles to leave the area. Large portions of the Study Area are deer fawning/elk calving areas, as shown in Figures 4.13 and 4.14 of the EIS. Disturbances caused by construction and heavy machinery during the calving/fawning periods could result in stress that might cause abortion of fetuses or the abandonment of young animals by their mothers. Large areas are also winter habitat, including critical wintering habitat for elk and deer. Construction-associated stresses could weaken animals during this particularly vulnerable period, and could also cause increased energy expenditure as animals moved away from construction. Serious as they are, however, such impacts would be only temporary, ending after construction was completed and populations had rebuilt to former levels.

More permanent effects would result from indirect growth-related impacts. Alternatives that would accommodate or encourage increased growth (sewering alternatives) could have serious consequences to wildlife populations. Such growth will require conversion of land to urban uses, with consequent loss of wildlife habitat. Most detrimental would be the loss of critical winter ranges which for deer and elk are shown in Figures 4.13 and 4.14 in the EIS. Loss of critical winter range to urban uses would probably cause a prompt, severe, and permanent decline in wildlife populations in the area. Loss of habitat in other wintering areas, fawning and calving areas and/or feeding areas would cause a more gradual but permanent decline in wildlife populations. Intrusion into riparian corrdors by growth could destroy critical roost trees for bald eagles or cause stress to the disturbance-sensitive birds. Either factor would result in a decline of this Federally threatened species in the area.

Increased disturbances to wildlife caused by increased human and pet activity associated with growth are other serious indirect impacts that could occur. This is a special concern where residential areas are adjacent to relatively unaltered wildlife habitat, as in this Study Area. Illegal shooting of wildlife, including raptors such as eagles, and poaching are very difficult to control when residential and wildlife areas are in close proximity. Domestic pets also impact wildlife populations. Dogs and cats are predatory in nature and will hunt wildlife even when adequately fed by their owners. Domestic pets can function as predators maintained at artificially high levels and as such can cause drmatic declines in wildlife populations. Cats will hunt primarily small mammals and birds. Dogs hunt these species as well as larger animals, and in packs can even kill deer and elk. Wildlife populationsare most vulnerable to human and pet disturbances during the winter and when the young are new and helpless.

Mitigation Measures

Direct wildlife losses due to pipeline and facilities construction can be mitigated by restoring the habitat as quickly as possible. Construction-related disturbances can be effectively avoided by staging activities so that construction does not occur in a critical habitat during a critical time period.

The most effective way to minimize indirect growth-related impacts on wildlife is by strict adherence to the desired growth patterns designated in the La Plata County Comprehensive Plan. Adherence to the plan would channel growth into existing urban areas or their peripheries, and would discourage development in rural areas. New development would thus be directed into areas where wildlife is already substantially disturbed. Adherence to land use plans and ordinances is a local matter, however, and EPA has limited authority over decisions made at the discretion of local authorities.

The indirect growth-related impacts of urban intrusion into critical winter range can be partially mitigated by identifying the most important habitat, placing it under public ownership to prevent development, and applying wildlife management practices to increase its carrying capacity. Intrusion into riparian corridors can be prevented by ordinances prohibiting development of flood plains, and by developing greenbelt parkways in riparian areas. Particularly sensitive areas such as bald eagle roost trees, peregrine falcon nesting or hacking sites, and critical wildlife winter range should be closed to public access during critical periods. Strict enforcement of leash laws would substantially reduce harassment and predation of wildlife by pets.

BIOLOGICAL RESOURCES - AQUATIC LIFE

Project Impacts

Degraded water quality has an adverse impact on aquatic life. The results of water quality monitoring conducted in the Study Area are inconclusive and do not confirm degradation of water resources by existing wastewater treatment systems. However, many of the package plants in the Study Area have a history of operations problems, and some on-site disposal systems have inadequate percolation rates or are located in areas of high ground water. The No Action alternative would result in a continuation of this situation.

Enactment of Formation of Maintenance District alternatives would probably have a beneficial impact on aquatic life. By requiring replacement of failing systems and providing better operation and maintenance of existing systems these alternatives would either improve aquatic habitat or protect it from further degradation.

Alternatives providing sewers would eliminate the possibility of aquatic habitat degradation by inadequately treated wastewater. However, by providing treatment and surface water disposal of sewage that is currently disposed by evaporation or land-disposal systems, these alternatives will introduce additional amounts of heavy metals and nutrients such as nitrogen and phosphorus to the aquatic habitat. Heavy metals plus residual chlorine released with the effluent could have toxic effects on the biota. Increased nutrient loads could promote algal blooms with associated oxygen depletions that can result in fish kills.

Indirect growth-related impacts could also be associated with providing sewers and surface water discharge of effluent. Increased population would produce increased amounts of nutrients and heavy metals, which would be released with increased amounts of treated effluent. In addition, increased conversion of rural land to urban areas would result in increased runoff as less water would be absorbed by the ground. The runoff would carry silt, sediment, and heavy metals associated with urban areas, all of which would degrade the aquatic habitat.

Mitigation Measures

The best way to mitigate aquatic habitat degradation is to insure that all wastewater treatment facilities, from septic tanks to central treatment plants, are operating properly at all times and are providing the best sewage treatment possible. The addition of "new" wastewater to aquatic habitats by sewering alternatives is inherent in the management strategy, and little can be done to alter this impact. In addition, little can be done to mitigate increased wastewater volumes and surface runoff problems associated with increased growth.

METEROLOGY AND AIR QUALITY

Project Impacts

Meterology is neither expected to have impacts on nor be impacted by any of the proposed alternatives.

Indirect growth-related impacts to air quality in the Study Area are expected if alternatives that remove constraints to development (sewering alternatives) are enacted. Primary sources of air pollution in the area are automobiles and home fireplaces. Increased numbers of both with proportionate increases in air emissions are expected with increase in population in the area.

Mitigation Measures

No mitigation measures are proposed for air quality impacts.

ENERGY RESOURCES

Project Impacts

The No Action and Formation of Maintenance District alternatives would result in no net change in energy consumption. While such systems as on-site septic tank-leach field systems require no energy, other facilities in the Study Area, including several of the package plant systems which are overloaded, are quite energy intensive. Providing sewers under the recommended plans for the Hermosa, Junction Creek, and Grandview/Loma Linda areas would result in annual energy savings of 206,000 kwh, 26,000 kwh and 28,000 kwh, respectively, due primarily to the replacement of inefficient package plants.

Sewering alternatives that could accommodate or encourage increased growth in the Study Area would have indirect impacts on energy consumption. Increases in population in the Study Area could be expected to produce a proportional increase in energy consumption.

Mitigation Measures

Providing sewers to areas where energy intensive package plants currently treat wastewater is in effect a mitigation for current high energy consumption in sewage treatment. Indirect growth-related increases in energy consumption could partially be mitigated if local governments would amend building codes to require new construction to include adequate insulation and other energy conserving devices.

TRANSPORTATION

Project Impacts

There will be direct impacts on the road system in the Study Area as a result of any alternatives implemented. Under the No Action and Formation of Maintenance District alternatives, on-site disposal units would have to be pumped periodically and the septage hauled by truck to the Durango wastewater treatment plant. Enactment of Maintenance District alternatives would probably result in increased pumper truck traffic because of better maintenance, including more frequent pumping, of existing facilities. Direct impacts of alternatives involving construction of new facilities include movement of construction equipment on area streets and possible road damage done by heavy equipment. Construction of interceptors along highways could disrupt traffic during the period of construction, while construction of new pipelines across roadways would both disrupt traffic and destroy short segments of the current roadbed.

Indirect effects are related to the additional vehicular traffic that will result from growth accommodated by providing sewers in areas presently constrained by inadequate wastewater treatment. It is not expected that significant road capacity problems in the Study Area will occur as a result of the growth associated with this project. However, any roadway problems and adverse driving conditions that presently occur during the winter season are likely to continue and get worse as more vehicles enter the area.

Mitigation Measures

Standard engineering practices and staging of construction to disrupt traffic flow as little as possible should be used during construction activities. No additional measures are proposed as part of this wastewater management plan.

LAND USE AND POPULATION CONSIDERATIONS

Project Impacts

One of the most important issues associated with installation of sewers in the Study Area is the potential effect on growth rates and distribution patterns. Development patterns are restricted throughout the Study Area by physical constraints such as flood plains and steep slopes. In those areas suitable for development, institutional constrains influence growth patterns. For example, the Colorado Health Department requires at least three acres of land per dwelling unit in unsewered areas to accommodate on-site disposal systems. The availability of sewers may relax this constraint on growth and may facilitate high density growth and strip development along pipeline alignments. Desired growth patterns have been adopted by the Planning Commission for four sectors (planning regions)of the Study Area. However, land use ordinances are subject to annual review. In view of the competing interest regarding land use management practices in the Study Area, the issue of growth facilitation resulting from sewer installation is considered significant.

The overall impact of sewers on population growth and land use change in the six Study Areas is variable and depends, in part, on the natural attractiveness of the areas in question. Without sewers, the development potential and the relative attractiveness of each area would remain as they are now. Durango West and the locations near the city but outside the 201/EIS Study area (Riverside, Hillcrest Mesa and the close-in areas on Florida Road) would be the most probable high-growth areas, with capacity for approximately 8,000 of the 20,000 new residents of La Plata County expected between now and the end of the century. The Hermosa area, another attractive location, could take another 1,000 to 1,500 residents in the development already planned. Edgemont Ranch would be another likely growth area if and when it develops, with room for an estimated 1,500 residents as well. Together, these areas would accommodate an estimated 11,000 new residents, or almost 60 percent of the expected countywide population increase.

The implementation of a sewer system in the Grandview-Loma Linda Study Area would have the greatest potential impact on the future distribution of population and land use, because it would remove a major development constraint there. The combination of wastewater facilities and level, less expensive land (land prices could, however, be expected to rise) would make the area an attractive one for new development. If the desired growth pattern is changed to allow higher density development, Grandview-Loma Linda could become a high-growth area. It is not clear whether the increased development potential and attractiveness in the area would result in a rearrangement of the 11,000 residents expected to locate in the Durango area of La Plata County or would increase the area's share of new county residents; Grandview-Loma Linda would be a feasible alternative for residential location not only to Durango West and Hermosa but also to Bayfield.

Implementation of projects in other areas would increase the development potential but not relative attractiveness of those area. It therefore would result in a marginal amount of additional development - primarily commercial along U. S. Highway 160 in the Lightner Creek area and Waterfall Village in the West Animas area - but not a significant shift in the distribution of population growth.

Mitigation Measures

Changes in land use could be minimized by strict adherence to the desired growth patterns designated in the La Plata County Comprehensive Plan. Adherence to the plan would channel growth into existing urban areas or their peripheries, and would discourage development in rural areas. However, adherence to land use plans and ordinances is a local matter and EPA has limited authority over decisions made at the discretion of local authorities.

SOCIOECONOMIC CONSIDERATIONS

Project Impacts

The issue of who benefits versus who pays is considered significant for sewering alternatives. Sewers will impose an economic burden on residents who are presently using satisfactory systems but who will be required to connect and/or contribute financially to the new sewer system. The sewering alternatives are designed to correct wastewater management problems caused by a minority of systems which are operating inadequately. These problems are generally more acute with package plant operations than with individual on-site units. Instead of having owners of faulty systems paying for the repair/replacement of their own systems, the sewering alternatives require all residents in proposed service areas, many of whom have adequate systems, to support a plan to correct problems created by the minority.

An additional cost which may affect proposed service area residents for alternatives which connect to the Durango System would be in the form of higher taxes resulting from becoming annexed to the City. Connection to the Durango System would most likely fall under the implied consent rules of the City. Implementation of sewers, in this case, may represent an agreement by the residents to be annexed to the City at some future date by accepting City services.

Indirect long-term effects of the sewering alternatives on the local economic situation are growth-related. Growth and development introduce new jobs, enlarge the tax base, and probably would result in more recreationists being attracted to the Study Area. On the other hand, such growth also entails increased demands on transportation facilities, urban services, public utilities, and other facilities. These latter costs are often diffuse and may be at least partially hidden in what appear to be inflationary increases in property tax, service fees, sales tax, etc. There have been a number of studies that have "conclusively" proved both that the economic benefits of growth outweigh the resulting rise in demand for services, and that the opposite is true. The long-term economic consequences of growth for any one area are probably highly dependent on the conditions specific to that area.

Mitigation Measures

No mitigation measures are proposed for socioeconomic impacts.

CULTURAL RESOURCES

Project Impacts

Impacts associated with the project may include the damaging or destruction of previously unknown archeological sites by any of the alternatives involving construction of pipelines or new treatment facilities.

Mitigation Measures

To protect curltural resources from damage associated with construction of new facilities, the EPA has imposed the following grant conditions:

> No payment in excess of 25 percent of the Step 2 grant shall be made prior to completion of a cultural/historical resources survey that satisfies the requirements of the construction grants program. This condition is designed to provide early identification of any conflicts of the plan with these resources so that alternatives can be investigated before a major commitment of Step 2 funds has been made.